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ABSTRACT

This curriculum guide for automatic brakes service is one in a series of automotive service speciality publications that is based on the National Institute of Automotive Service Excellence task lists. The curriculum is composed of four units. Each unit of instruction may contain some or all of the following components: objective sheet, suggested activities, extensions and options, information sheets, supplements, assignment sheets, job sheets, practical tests, written tests, and answers to the activity sheets, assignment sheets, and written tests, all of which are included in the instructor edition. Extensions and options, supplements, transparency masters, and activity sheets are optional components that may be included in some or all units. The student workbook includes the objective sheets, information sheets, supplements, activity sheets, assignment sheets, and job sheets. The four units cover these topics: servicing brake hydraulic system and wheel bearings, servicing drum brakes, servicing disc brakes, and servicing antilock brakes. The guide includes a basic skills matrix and curriculum and duty/task crosswalk.(YLB)

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Automotive Service Series
Brakes Specialist

ED 385 674

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CE 068 514

CIMC

Teacher Edition

94-010078 (Second Edition)

Oklahoma Department of
Vocational and Technical Education
1500 West Seventh Avenue
Stillwater, OK 74074-4364

TI1227

Brakes Specialist

Developed by the
Curriculum and Instructional Materials Center
for the Division of Trade and Industrial Education
Oklahoma Department of Vocational and Technical Education

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FOREWORD

This is one in a series of eight automotive service specialty publications that is based on the National Institute of Automotive Service Excellence (ASE) task lists. This series provides instruction for all high-priority competencies established by ASE and will contribute greatly to an auto service technology program's ability to meet the requirements of a nationally certified training school.

The ASE competencies are developed by industry to meet the industry's need for quality technicians. This curriculum addresses that need. The industry and education committee that has validated the technical accuracy of this material is commended for outstanding service and commitment to the quality of these instructional units. The instructors and students who use this material are challenged to have the same commitment to excellence.

We trust that this instructional material will meet students' needs as they prepare for careers in automotive brakes service.

Dr. Roy Peters, Jr.
State Director
Oklahoma Department of
Vocational and Technical Education

Ivan Armstrong
State Supervisor
Trade and Industrial Education
Oklahoma Department of
Vocational and Technical Education

PREFACE

The purpose of *Brakes Specialist* is to continue the students' training in the automotive service trade by providing instruction in this specialty area. This publication is one in a series of eight publications for automotive specialty areas. Other areas included in this series are steering and suspension, engine performance, electrical, heating and air conditioning, automatic transmission/transaxle, manual drivetrain and axle, and engine repair.

Instructors are faced with the challenge of teaching the skills and related information necessary for their students to become the highly qualified automotive service specialists that are in demand today. This curriculum guide is designed to help instructors meet this challenge. The objectives in this curriculum are based on those National Institute of Automotive Service Excellence (ASE) tasks that are required of an Automotive Brakes Specialist.

Lynnette Johnson
Curriculum Development Specialist
Curriculum and Instructional
Materials Center

ACKNOWLEDGEMENTS

The Curriculum and Instructional Materials Center (CIMC) extends its appreciation to those who played important roles in the development of *Brakes Specialist*.

Special appreciation is extended to the professional automotive technicians and vocational educators who so generously contributed their substantial expertise, talents, and time to serve on the Brakes Specialist task analysis and validation committees:

Dewayne Arndt
Robert Betche
Dan Buckner
Charlie Brackett
Jerry Gass

C. C. Anderson
John W. Edsall
Tommy E. Griffith
Jon Priebe
Bob Sharp

We also want to thank the state director, Dr. Roy Peters, Jr., and assistant state director, Dr. Charles O. Hopkins, for their continued support throughout this project. The state supervisor of Trade and Industrial Education, Ivan Armstrong, who provided leadership and direction on this project also deserves special recognition and thanks.

Only with the close cooperation of the Curriculum and Instructional Materials Center staff was this curriculum developed. Sincere thanks are shared with the CIMC team leaders:

Mr. John Friedemann
CIMC Coordinator

Dr. Lynna Ausburn
Development Coordinator

Special recognition is due to the CIMC project development team assigned to this project: Judith Armstrong, Alan Barker, Sue Buck, Billy King, Chuck Pendergast, Suzanne Perry, Marsha Sneed, Brenna Tillman, Charlotte Tarkington, Terri Tomson, and Susan Walker.

Special appreciation and thanks are also extended to other individuals within the Oklahoma Department of Vocational and Technical Education: Rose Primeaux, Stephanie Smola, and Margie Kirkendall in Word Processing; Bob Davis and the artists in the Art Department; Tom Fields who did the photographic work; Noel Wilcoxson, Danny Darrow, and Diane Ensign and their staffs at the ODVTE Print Shop

We would like to thank Tim Ritter of Tim's Automotive for his generous gift of time and expertise.

And finally, a very special acknowledgment goes to Chuck Pendergast, the technical adviser for this project, without whose expert collaboration, advice, support, review, and encouragement this curriculum would not have been possible.

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Curriculum Development Specialist
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and Technical Education

USE OF THIS PUBLICATION

INSTRUCTIONAL UNITS

Brakes Specialist contains four units. Each instructional unit includes some or all of the basic components of a unit of instruction: Objective Sheet, Suggested Activities, Extensions and Options, Information Sheets, Supplements, Transparency Masters, Activity Sheets, Assignment Sheets, Job Sheets, Practical Tests, Written Tests, and answers to the Activity Sheets, Assignment Sheets, and Written Tests, all of which are included in the Instructor Edition. Extensions and Options, Supplements, Transparency Masters, and Activity Sheets are optional components which may be included in some or all of the units. The Student Workbook includes the Objective Sheets, Information Sheets, Supplements, Activity Sheets, Assignment Sheets, and Job Sheets. Practical Tests and Written Tests may be duplicated for classroom use or additional copies may be purchased by calling 1-800-654-4502 out of state, and 1-800-522-5810, ext. 589 in-state.

The unit components focus on measurable and observable learning outcomes. Instructors are encouraged to supplement, personalize, localize, and motivate with these materials to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. By carefully studying each unit of instruction, the instructor will be able to plan presentations and demonstrations to meet the needs of the students as well as determine the following:

- How to use the materials for independent study
- Amount of material to cover in a single class period
- Skills that must be demonstrated
  - Supplies and equipment needed
  - Amount of class time needed for demonstrations
  - Amount of time needed for student practice
- Supplementary materials to order such as pamphlets, videos, or software
- Resource people to contact

Objective Sheet (White Pages)

Each unit of instruction is based on the knowledge and skills needed for successful employment in an occupational area. What the student must know and be able to do has been translated into performance objectives which are stated in two forms. ***Unit objectives*** state the subject matter to be covered in a unit of instruction, what the student should be able to do and what standard will be used to determine whether the student has achieved competency. ***Specific objectives*** outline the teaching sequence and state the performance necessary to meet the unit objective.

The objectives can also help determine teaching strategies and instructional methods. Instructors will need to decide how each objective can best be taught (individualized or by class instruction) to their students prior to beginning the unit. Instructors should feel free to modify, delete, or add objectives in order to meet the needs of the students and the community. If objectives are added, the instructor should remember to supply the needed Information Sheet material, Assignment Sheets, Job Sheets, Practical Tests, and Written Test items.

Suggested Activities (Pink Pages) – **Instructor's Edition only**

This component is designed to assist the instructor during the preparation stage of the teaching/learning process by providing suggestions for delivery, enrichment, and application. Teaching suggestions are included for each objective. The instructor should read the Suggested Activities before teaching the units to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the instructor will vary according to the particular unit.

References used in the development of each unit are listed in the Suggested Resources section along with print and non-print media that may be used to teach the unit. These materials can be used by the instructor to supplement his or her knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

Extensions and Options (White Pages) – **Instructor's Edition only**

Extensions and Options are supplemental material that is not testable or graded and is nice-to-know. Extensions and Options provide the instructor with additional activities, fact sheets, art, controversial items, and extra practice sheets. They may also include items for the gifted or remedial student. Extensions and Options are used at the discretion of the instructor.

Information Sheets (Green Pages)

The Information Sheet provides content essential for meeting the cognitive objectives on the knowledge and comprehension level of Bloom's taxonomy of educational objectives. The Information Sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. It also may be used for coordination activities and advisory committees.

Students should read the Information Sheet before the information is discussed in class. Space is provided in the margins for students and instructors to add notes that supplement, localize, personalize, or provide motivation for each unit.

Supplements (Green Pages)

Supplements include instructions that can be used for solving problems or reinforcing learning. The information presented in a Supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the Assignment Sheets or Job Sheets. While Supplements are not tested directly, they may be used to assist in meeting the performance objectives.

Transparency Masters (White Pages) – **Instructor's Edition Only**

The instructor should make transparencies from the Transparency Masters included in the Instructor's Edition. Use of these transparencies will allow the instructor to direct class discussions which reinforce and expand the information in the Information Sheets.

Instructional Supplements (Pink Pages) — **Instructor's Edition only**

Instructional Supplements provide suggestions for teaching the basic skills included in the Activity Sheets, Assignment Sheets, or Job Sheets.

Activity Sheets (Tan Pages)

The purpose of Activity Sheets is to provide activities which support several objectives. Activity Sheets may vary greatly in their number and design from unit to unit. Answer sheets may or may not be included. In *Brakes Specialist*, each unit has an Activity Sheet which asks questions in the style used on ASE tests. Activity Sheet answers are on pink pages in the instructor's edition.

Assignment Sheets (Tan Pages)

Assignment Sheets provide students with information and exercises to problems that address learning levels at or above the application level of Bloom's taxonomy. Assignment Sheets provide written exercises for instruction and practice of a specific objective. The introduction to the Assignment Sheet explains how the Assignment Sheet relates to the subject area and unit objectives and may provide instructional information or refer students to another component for such information.

Assignment Sheets are intended to provide students with practice in exercising higher-order thinking skills. Often, Assignment Sheets will contain case studies, story problems, or other situations in which the student must analyze the circumstances and determine correct responses. In *Brakes Specialist*, many Assignment Sheets are used to give the student experience in using service manual diagnostic charts. Assignment Sheets may be given to the students for completion in class or for homework. Answer sheets are provided in the instructor's edition..

Job Sheets (Blue Pages)

Job Sheets are another important segment of a unit of instruction. The Job Sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure to complete each task or job. Diagrams, photographs, and illustrations are provided to assist students in achieving the skill.

The instructor should demonstrate the procedure outlines in each Job Sheet. The instructor may need to localize the procedure according to the equipment and supplies available in the local lab or shop situation. Job Sheets furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

The procedural steps in the Job Sheets may contain special warnings and cautions which alert the student to safety hazards involved in the procedure. Routine safety precautions which must always be employed in the automotive shop have not been included. Students should be encouraged to follow such standard precautions as a matter of routine, not merely in response to instructor or curriculum direction.

Practical Tests (Yellow Pages) – **Instructor's Edition only**

The Practical Tests are designed to assist the instructor in the evaluation of the students' psychomotor activities (Job Sheets). The Practical Test provides instructors with an instrument for determining a student's level of ability in performing the procedure stated on the Job Sheet.

Written Test (Yellow Pages) – **Instructor's Edition only**

This component provides criterion-referenced evaluation of every cognitive objective listed in the unit of instruction. If objectives have been added, deleted, and modified, appropriate changes should be made on the test.

The test may be written or oral. It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered.

The acceptable response on a unit test, eighty-five (85) percent in most units, may be raised or lowered to fit the topic or students' ability levels. The percentage applies to the overall score, not to each individual question. The final unit grade should be obtained by using the score on the Written Test along with teacher evaluations of student demonstrations of the desired skills.

Answers to Activity Sheets, Assignment Sheets, and Written Tests (pink pages) – **Instructor's Edition only**

These components are designed to assist the instructor in evaluation of student performance. They are available in the teacher's edition only.

PAGE NUMBERING

Each unit in ***Brakes Specialist*** will be recognized by the unit number in roman numerals. Each unit in the publication begins with page 1. Each page number gives the component name, book title, unit number, and page number within the unit. Since the Instructor's Edition of CIMC publications are loose-leaf, this system of page numbering was recently adopted so that pages from different manuals would not get mixed up. The page number for the objective sheet in **Servicing Disc Brakes**, which is unit III, would look like this:

> OBJECTIVE SHEET - **Brakes Specialist**
> **CIMC** - Unit III - 1

METHODS OF DISSEMINATING MATERIAL

For best results, provide student materials for each student. Student workbooks contain Objective Sheets, Information Sheets, Supplements, Activity Sheets, Assignment Sheets, and Job Sheets. Practical Tests, and Written Tests are packaged separately for students, and can be stored until needed. Students should be allowed to take their materials home at the end of the course.

TEACHING METHODS

Keeping students motivated is a challenge. Supplement the objectives by providing personal experiences and current information. If you are going to teach the material in a group setting, prepare for the unit be deciding the best way to teach each objective and allow for student input.

If you are going to follow a plan for individualized instruction, provide opportunities that will allow each student to become involved in planning for and being responsible for his or her own education.

COMPETENCY PROFILES

A Competency Profile is available for each CIMC publication. Competency Profiles document student performance. The profile contains a list of the specific job competencies that a student should achieve before leaving the training program. Profiles should be distributed as required.

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and to indicate the correction on the copy. Mail this information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and
Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

For a free catalog, a list of new publications, or other instructional materials information call 1-800-522-5810, extension 589.

RESALE

BASIC SKILLS IN CURRICULUM

The CIMC has always been mindful of the importance of reinforcement (and sometimes remediation) of students' academic skills as they progress through vocational training, and has always included activities in its materials to enhance and promote use of these skills.

Recent state and federal legislation mandates vigorous basic skills development in vocational education in the wake of demands by industry that workers *must* be academically, as well as technically, competent, given the nature of the highly complex work place. In response, the CIMC has taken the following steps to document that, indeed, the instructional materials *do* combine academic skills training with the vocational training. In addition, concerted efforts have been made to "beef up," or enhance the basic skills instruction already present. Following is a brief description of those processes:

Basic Skills Icons and Enablers

To assist teachers and students in identifying activities that promote basic skills development, the CIMC has implemented a marking system that uses simple graphic symbols, or icons, and a list of specific tasks, or enablers, to identify the basic skill or skills that are called for in each job or assignment sheet.

Each of the nine broad basic skills areas—reading, writing, mathematics, science, oral communication, interpersonal or relating, creative thinking and problem solving, employability, and social studies—is represented by the icon presented below.

Reading

Writing

Math

Science

Oral Communication

Interpersonal or Relating

Creative Thinking/Problem Solving

Employability

Social Studies

When an activity involving one of these basic skills is identified, the corresponding icon is placed in the left-hand margin of the job or assignment sheet. The basic skills training is further defined by retrieving the specific, or enabling, skill that is required by consulting a list of over two hundred and fifty enablers that has been compiled and grouped with each general basic skill. This enabling skill is placed directly below the icon.

As an example, an exercise that requires a student to conduct library research would make necessary the use of specific reading comprehension and research and reference skills. The basic skills that the exercise promotes would be depicted in the left-hand margin as follows.

[Text]

Reading Comprehension Skills

- Gain information

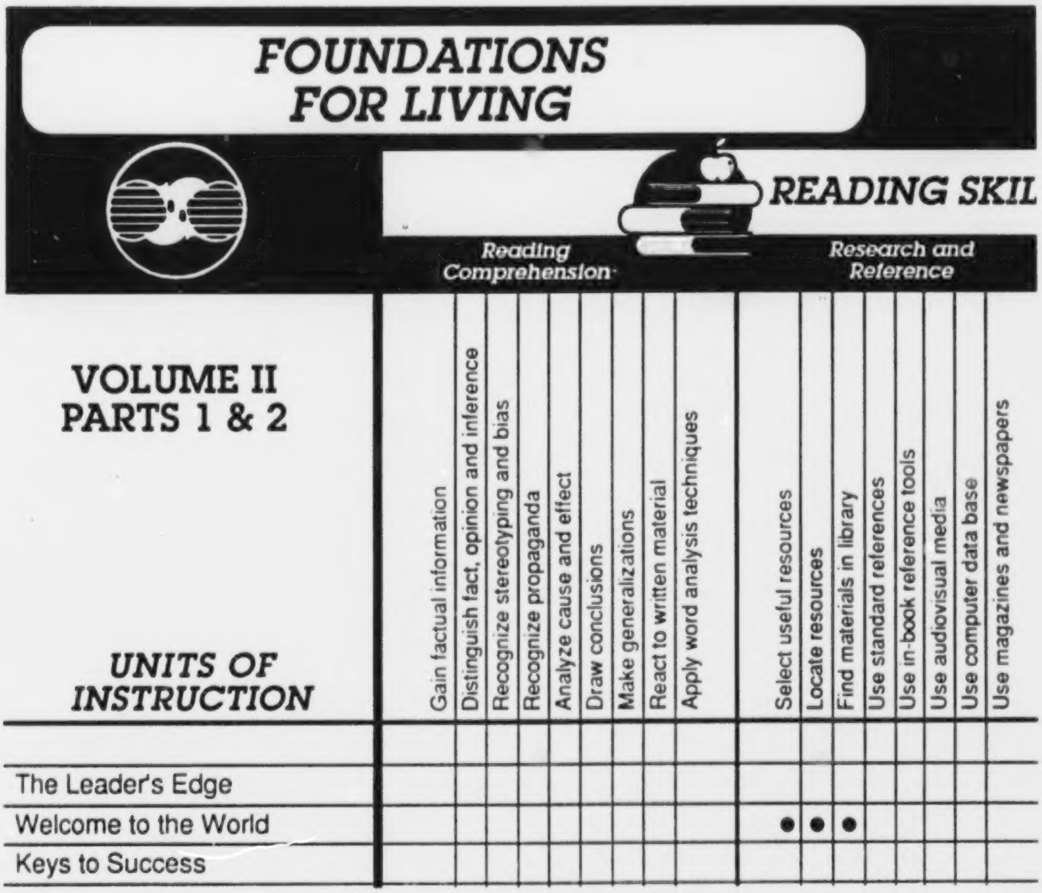
Research and Reference Skills

- Select useful resources
- Find materials in library

Basic Skills Documentation Matrix

Another component of the CIMC basic skills instructional plan is the "Basic Skills Documentation Matrix." The matrix graphically summarizes the basic skills training included in the vocational program, unit by unit. It should be helpful to teachers in planning their instruction, and to administrators as documentation that basic skills **are** being address during the vocational training.

The matrix is currently being produced as an attractive 22" x 34" wall hanging. Two copies are included with order of a teacher's book. Matrices for future publications will be in the form of an 8" by 11" foldout included in each teacher's packet.



FOUNDATIONS FOR LIVING

READING SKIL

VOLUME II PARTS 1 & 2

UNITS OF INSTRUCTION	Reading Comprehension									Research and Reference							
	Gain factual information	Distinguish fact, opinion and inference	Recognize stereotyping and bias	Recognize propaganda	Analyze cause and effect	Draw conclusions	Make generalizations	React to written material	Apply word analysis techniques	Select useful resources	Locate resources	Find materials in library	Use standard references	Use in-book reference tools	Use audiovisual media	Use computer data base	Use magazines and newspapers
The Leader's Edge																	
Welcome to the World										●	●	●					
Keys to Success																	

Matrices have been developed for most CIMC publications. For more information on those available for other programs, call CIMC Resale, 1-800-654-4502.

Suggested Evaluative Criteria

In some instances a "Suggested Evaluative Criteria" chart is included on assignment sheets to assist the teacher in scoring the basic skills portion of the assignment. As the title implies, these are suggestions only, and should be of use to the vocational teacher who has little experience or training in teaching or evaluating academic exercises such as composition writing. The criteria will usually appear with writing, oral presentation, or major project assignments. For example, suggested evaluative criteria given for a writing assignment would recommend number of points to be assigned for neatness of report, content, use of note cards, spelling, and grammar.

SUGGESTED
EVALUATIVE CRITERIA

1.	Note cards with proper information	10 points
2.	Bibliography	5 points
3.	Footnotes	5 points
4.	Language skills (grammar, spelling, capitalization, punctuation, complete sentences)	15 points
5.	Composition skills (topic sentences, introductory paragraph)	15 points
6.	Content	45 points
7.	Neatness of report	5 points
	TOTAL	100 points

Instructional Supplement

Job and/or assignment sheets are accompanied by a "Basic Skill Instructional Supplement." These instructional supplements are grouped together: e.g., all job sheet instructional supplements will appear as a group in each unit. These series will appear directly in front of the exercises with which they are to be used—job or assignment sheets.

The supplement is a tool for the instructor to use in helping students apply the basic skills in their assignments. Some supplements are appropriate for use with all students; some are for use only with those students who do not understand the academic skills called for in the exercise. The supplement is similar in format and content to the Suggested Activities portion of the CIMC materials.

INSTRUCTIONAL SUPPLEMENT

MOLDING "C" SHAPING 5

ASSIGNMENT SHEET

Skill development for: MATHEMATICS

- Introduce the assignment to the students by discussing with them the purpose of graphs. Stress the ability of graphs to represent numerical data in easy-to read, visual format.
- Use Student Supplement 3, "Interpreting Graphs," to review with students the major types of graphs and how they should be read.

Lynna Ausburn, Ph.D.
Development Coordinator

Billie Frazier
Copy Specialist

USING THE CIMC WRITTEN TESTS AS PRETEST AND POSTTEST TO MEASURE STUDENT PERFORMANCE GAINS

When you examine this book, you will notice that separate written pretests are not included in the units of instruction. Each CIMC unit contains only a single written test. This test should be used as **both** pretest and post test by giving it once before students start a unit and again when they have completed the unit.

The reason for using a single instrument as both pretest and posttest is so that direct comparison of each student's competencies before and after instruction can be made accurately. This comparison enables precise calculation, documentation, and evaluation of student **performance gains**.

Accurate performance gains analysis is an important requirement of the new Carl Perkins legislation for vocational education. Teachers can make an important contribution to the performance accountability mandated by the new federal legislation by carrying out accurate performance gains analysis for their students, and making this data available to students, parents, and administrators.

This analysis is easy to do and requires only simple calculations and record-keeping. Detailed information regarding performance gains analysis is contained in the CIMC publication, *Measuring Learning & Competency Gains: The Pretest/Posttest Approach*. In addition, the CIMC has developed a computer program, CARL, which will perform all necessary calculations and will print out a record form of all information required for gain score analysis. Copies of CARL and the publication are available through your local testing liaison, or through our resale unit, 1-800-654-4502.

ASE - CIMC CROSSWALK

The following crosswalk shows the correlation between the specific tasks on the task list prepared by the National Institute of Automotive Service Excellence (ASE) and the instructional components in this CIMC (Curriculum and Instructional Materials Center) curriculum. This curriculum was prepared from the ASE task list copyrighted in 1990.

NO.	ASE TASK	CIMC UNIT/ COMPONENT
A	**HYDRAULIC SYSTEM DIAGNOSIS AND REPAIR**	
A-1	**Master Cylinders**	
A-1.1	Diagnose poor stopping or dragging caused by problems in the master cylinder: determine needed repairs.	Unit 1, Assignment Sheets 1 & 2
A-1.2	Diagnose poor stopping, dragging, high or low pedal, or hard pedal caused by problems in the step bore master cylinder and internal valves (e.g. volume control devices, quick take-up valve, fast-fill valve, pressure regulating valve); determine needed repairs.	Unit 1, Assignment Sheets 1 & 2, & Job Sheet 7
A-1.3	Measure and adjust pedal pushrod length.	Unit 1, Job Sheet 7
A-1.4	Check master cylinder for defects by depressing brake pedal and observing brake action; determine needed repairs.	Unit 1, Job Sheet 6
A-1.5	Check master cylinder for secondary cup defects by inspecting for fluid leakage.	Unit 1, Job Sheet 6
A-1.6	Remove master cylinder from vehicle.	Unit 1, Job Sheet 6
A-1.7	Disassemble, clean, inspect master cylinder and re-usable parts and clean or hone cylinder bore (if necessary and recommended by manufacturer).	Unit 1, Job Sheet 8
A-1.8	Reassemble master cylinder.	Unit 1, Job Sheet 8
A-1.9	Bench bleed (check for function and remove air) all master cylinders.	Unit 1, Job Sheet 9
A-1.10	Install master cylinder in vehicle: test operation of the hydraulic system.	Unit 1, Job Sheets 8 & 11

NO.	ASE TASK	CIMC UNIT/ COMPONENT
A-2	**Fluids, Lines, and Hoses**	
A-2.1	Diagnose poor stopping, pulling, or dragging caused by problems in the brake fluid, lines, and hoses; determine needed repairs.	Unit 1, Assignment Sheet 1& Job Sheet 1
A-2.2	Inspect brake lines and fittings for leaks, dents, kinks, rust, cracks, or wear; tighten loose fittings and supports.	Unit 1, Job Sheet 1
A-2.3	Inspect flexible brake hoses for leaks, kinks, cracks, bulging, or wear; tighten loose fittings and supports.	Unit 1, Job Sheet 1
A-2.4	Replace brake lines (double flare and ISO types), hoses, fittings, and supports.	Unit 1, Job Sheet 1
A-2.5	Select, handle, store, and install brake fluids (including silicone fluids).	Unit 1, Information Sheet, Objectives 4 & 5
A-3	**Valves and Switches**	
A-3.1	Diagnose poor stopping, pulling, or dragging caused by problems in the hydraulic system valve(s); determine needed repairs.	Unit 1, Assignment Sheets 1 & 2
A-3.2	Inspect, test, and replace metering (hold-off), proportioning (balance), pressure differential, and combination valves.	Unit 1, Job Sheet 10
A-3.3	Inspect, test, replace, and adjust load or height sensing-type proportioning valve(s).	Unit 1, Job Sheet 11
A-3.4	Inspect, test, and replace brake warning light, switch, and wiring.	Unit 1, Job Sheet 12
A-3.5	Re-set brake pressure differential valve (if necessary).	Unit 1, Job Sheet 10
A-4	**Bleeding, Flushing, and Leak Testing**	
A-4.1	Bleed (manual, pressure, vacuum, or surge) and/or flush hydraulic system.	Unit 1, Job Sheet 2
A-4.2	Pressure test brake hydraulic system.	
B	**DRUM BRAKE DIAGNOSIS AND REPAIR**	
B-1	Diagnose poor stopping, pulling, or dragging caused by problems in the drum brake hydraulic assembly; determine needed repairs.	Unit 2, Assignment Sheet 1

NO.	ASE TASK	CIMC UNIT/ COMPONENT
B-2	Diagnose poor stopping, noise, pulling, grabbing, dragging, or pedal pulsation caused by problems in the drum brake mechanical assembly; determine needed repairs.	Unit 2, Assignment Sheet 1
B-3	Remove, clean, inspect, and measure brake drums; follow manufacturers' recommendations in determining need to machine or replace.	Unit 2, Job Sheets 1 & 2
B-4	Machine drum according to manufacturers' procedures and specifications.	Unit 2, Job Sheet 2
B-5	Using proper safety procedures, remove, clean, and inspect brake shoes/linings, springs, pins, adjusters/self-adjusters, levers, clips and other related brake hardware; determine needed repairs.	Unit 1, Job Sheets 3 & 11 and Unit 2, Job Sheet 3
B-6	Using proper safety procedures, clean and inspect brake backing (support) plates; determine needed repairs.	Unit 2, Job Sheet 3
B-7	Disassemble and clean wheel cylinder assembly; inspect parts for wear, rust, scoring, and damage; hone cylinder (if necessary and recommended by manufacturer); replace all cups, boots, and any damaged or worn parts.	Unit 2, Job Sheet 4
B-8	Lubricate brake shoe support pads on backing (support) plate, adjuster/self-adjuster mechanisms, and other brake hardware.	Unit 2, Job Sheet 5
B-9	Install brake shoes and related hardware.	Unit 2, Job Sheet 5
B-10	Pre-adjust brake shoes and install brake drums or drum/hub assemblies and wheel bearings.	Unit 2, Job Sheet 5
B-11	Reinstall wheel, torque lug nuts, and make final checks and adjustments.	Unit 2, Job Sheet 5
C	**DISC BRAKE DIAGNOSIS AND REPAIR**	
C-1	Diagnose poor stopping, pulling, or dragging caused by disc brake hydraulic problems; determine needed repairs.	Unit 3, Assignment Sheet 1
C-2	Diagnose poor stopping, noise, pulling, grabbing, dragging, or pedal pulsation caused by disc brake mechanical problems; determine needed repairs.	Unit 3, Assignment Sheet 1

NO.	ASE TASK	CIMC UNIT COMPONENT
C-3	Remove caliper assembly from mountings; clean and inspect for leaks and damage to caliper housing.	Unit 3, Job Sheet 1
C-4	Clean and inspect caliper mountings and slides for wear and damage.	Unit 3, Job Sheet 1
C-5	Remove, clean, and inspect pads and retaining hardware; determine needed repairs, adjustments, and replacements.	Unit 3, Job Sheet 1
C-6	Disassemble and clean caliper assembly; inspect parts for wear, rust, scoring, and damage; replace all seals, boots, and any damaged or worn parts.	Unit 3, Job Sheet 2
C-7	Reassemble caliper.	Unit 3, Job Sheet 2
C-8	Clean, inspect, and measure rotor with a dial indicator and a micrometer; follow manufacturers' procedures and specifications in determining need to machine or replace.	Unit 3, Job Sheet 3
C-9	Remove and replace rotor.	Unit 3, Job Sheet 3
C-10	Machine rotor according to manufacturers' procedures and specifications.	Unit 3, Job Sheet 4
C-11	Install pads, calipers, and related attaching hardware; bleed system.	Unit 3, Job Sheet 5, 6, & 7
C-12	Adjust calipers with integrated parking brakes according to manufacturers' recommendations.	Unit 3, Job Sheet 5, 6, & 7
C-13	Fill master cylinder to proper level with recommended fluid; inspect caliper for leaks.	Unit 3, Job Sheet 5, 6, & 7
C-14	Reinstall wheel, torque lug nuts, and make final checks and adjustments.	Unit 3, Job Sheet 5, 6, & 7
D	**POWER ASSIST UNITS DIAGNOSIS AND REPAIR**	
D-1	Test pedal free travel with and without engine running to check power boost operation.	Unit 1, Job Sheet 13
D-2	Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster with a vacuum gauge.	Unit 1, Job Sheet 13
D-3	Inspect the vacuum-type power booster unit for vacuum leaks; inspect the check valve for proper operation; repair or replace parts as necessary.	Unit 1, Job Sheet 13

NO.	ASE TASK	CIMC UNIT/ COMPONENT
D-4	Inspect and test hydro-boost system and accumulator for leaks and proper operation; repair and replace parts as necessary.	Unit 1, Job Sheet 14, 15, & 16
E	**MISCELLANEOUS (WHEEL BEARINGS, PARKING BRAKES, ELECTRICAL, ETC.) DIAGNOSIS AND REPAIR**	
E-1	Diagnose wheel bearing noises, wheel shimmy and vibration problems; determine needed repairs.	Unit 1, Assignment Sheet 1
E-2	Remove, clean, inspect, repack wheel bearings, or replace wheel bearings and races; replace seals; adjust wheel bearings according to manufacturers' specifications.	Unit 1, Job Sheet 3, 4, & 5
E-3	Check parking brake system; inspect cables and parts for wear, rusting, and corrosion; clean or replace parts as necessary; lubricate assembly.	Unit 3, Job Sheet 5, 6, & 7
E-4	Adjust parking brake assembly; check operation.	Unit 2, Job Sheet 6
E-5	Test parking brake indicator light(s), switch(es), and wiring.	Unit 2, Job Sheet 6
F	**ANTI-LOCK BRAKE SYSTEM (ABS) DIAGNOSIS AND REPAIR**	
F-1	Follow accepted service and safety precautions during inspection, testing, and servicing of anti-lock brakes system (ABS) hydraulic, electrical, and mechanical components.	Unit 4, Information Sheet 9.
F-2	Diagnose poor stopping, locking, pulsation, noise, and skidding problems caused by anti-lock brake system (ABS) hydraulic system; determine needed repairs.	Unit 4, Assignment Sheet 2
F-3	Perform anti-lock brake system (ABS) hydraulic system warning light sequence test at startup; determine needed repairs.	Unit 4, Job Sheet 1
F-4	Diagnose anti-lock brake system (ABS) system electronic control system using self diagnosis and/or recommended test equipment; determine needed repairs.	Unit 4, Assignment Sheet 3
F-5	Diagnose pedal feel to determine anti-lock brake system (ABS) operation/non-operation; determine needed repairs.	Unit 4, Assignment Sheet 1

NO.	ASE TASK	CIMC UNIT/ COMPONENT
F-6	Discharge integral anti-lock brake system (ABS) pressure to facilitate diagnosis and repair.	Unit 4, Job Sheet 2
F-7	Fill anti-lock brake system (ABS) master cylinder with recommended fluid to proper level following manufacturer's procedures: inspect system for leaks.	Unit 4, Job Sheet 3
F-8	Bleed integral anti-lock brake system (ABS) front and rear hydraulic systems following manufacturers' procedures.	Unit 4, Job Sheet 4
F-9	Perform a pressure diagnosis on integral anti-lock system (ABS) fluid pressurization (hydraulic boost) system: determine needed repairs.	Unit 4, Job Sheet 6
F-10	Remove and install hydraulic anti-lock brake system (ABS) components following manufacturers' procedures and specifications.	Unit 4, Job Sheet 7
F-11	Remove, clean, and inspect speed sensors: determine needed repairs.	Unit 4, Job Sheet 5
F-12	Measure wheel speed sensor air gaps: compare to manufacturers' specifications: determine needed repairs.	Unit 4, Job Sheet 8
F-13	Perform individual wheel sensor pin test.	Unit 4, Job Sheet 9
F-14	Remove, clean, and inspect speed sensor rotors/shafts: replace as necessary.	Unit 4, Job Sheet 5

OBJECTIVE SHEET

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

INTRODUCTION

If all the systems in an automobile were listed in their order of importance, the brake system would probably head the list. Most drivers have experienced the inconvenience caused by an engine that would not start, and many remember a winter's night when the heating system gave them nothing but cold air. A failure in the hydraulic brake system, however, is much more than a mere inconvenience. Failure in the brake system can cause property damage, serious injury, and even death. The brakes specialist must always remember that the quality of any brake service is measured only in terms of safety.

PREREQUISITES

Before studying this unit, the student should have successfully completed the core curriculum, *Introduction to Automotive Service*.

UNIT OBJECTIVE

After completing this unit, the student will be able to diagnose hydraulic system and wheel bearing problems and service these brake systems. The student will demonstrate these competencies by completing assignment sheets, job sheets, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to:

1. Recognize definitions of terms associated with the brake hydraulic system by choosing the correct definition from lists of three choices.

2. Label the basic components of a hydraulic brake system indicated on an illustration.

3. List the steps of hydraulic brake operation in order.

4. Define the characteristics of good brake fluid.

5. Recognize guidelines for handling and storing brake fluid.

6. Complete statements describing hydraulic lines and fittings.

7. Determine the correct specialty tool to use to service the hydraulic system and wheel bearings.

8. Complete drawings of the hydraulic circuits for dual braking system designs.

9. Evaluate asbestos safety practices.

10. Match terms associated with wheel bearings to their definitions.

11. Identify types of wheel bearings shown in illustrations.

12. List the purposes of wheel bearings.

13. Label the parts of a tapered roller wheel bearing indicated on an illustration.

14. Recognize properties of wheel bearing grease.

15. Label the parts of a dual master cylinder indicated on an illustration.

16. Match the names and functions of combination valve components to an illustration.

17. Label types of power-assist units shown in illustrations.

18. Label the parts of a vacuum power-assist unit indicated on an illustration.

19. Label the major parts of a hydraulic power-assist unit (mechanical pump) indicated on an illustration.

20. Label the major parts of a hydraulic power-assist unit (electrical pump) indicated on an illustration.

21. Diagnose brake system hydraulic and wheel bearing problems. (Assignment Sheet 1)

22. Diagnose power-assist unit problems. (Assignment Sheet 2)

23. Inspect, test, and service hydraulic brake lines and hoses. (Job Sheet 1)

24. Bleed or flush a hydraulic braking system. (Job Sheet 2)

25. Remove, clean, inspect, and repack (or replace and pack) wheel bearings and replace seals. (Job Sheet 3)

26. Adjust wheel bearings. (Job Sheet 4)

27. Remove and replace front-wheel drive nonserviceable sealed wheel bearings. (Job Sheet 5)

28. Remove and replace a dual master cylinder. (Job Sheet 6)

29. Remove and replace a take-up valve in a quick take-up master cylinder. (Job Sheet 7)

30. Overhaul a master cylinder. (Job Sheet 8)

31. Bench bleed a master cylinder. (Job Sheet 9)

32. Remove and replace a combination valve. (Job Sheet 10)

33. Remove, adjust, and replace a load-sensing proportioning valve. (Job Sheet 11)

34. Check and adjust brake stop light and warning light systems. (Job Sheet 12)

35. Inspect a vacuum power-assist unit and check valve for leaks and proper operation. (Job Sheet 13)

36. Inspect a hydraulic power-assist unit (mechanical pump) for leaks and proper operation. (Job Sheet 14)

37. Test, remove, and install a hydraulic power-assist unit (mechanical pump). (Job Sheet 15)

38. Inspect and overhaul a hydraulic power-assist unit (electrical pump). (Job Sheet 16)

SUGGESTED ACTIVITIES

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

PREPARATION

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the Delivery section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special needs students.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the Suggested Resources section. Include in your selection media that demonstrate Job Sheet skills. Videotape your own demonstrations of Job Sheet procedures if unable to obtain suitable media.

- Obtain Competency Profiles for this unit.

  NOTE: Competency Profiles for this book are available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

- Prepare classroom and shop. Display posters, charts, safety signs, etc., that emphasize hydraulic brake system and wheel bearing service. Have articles, specification guides, mock-ups, and other references about hydraulic brake and wheel bearing service available for student use. Display various types of DOT brake fluid, wheel bearings, and master cylinders.

- The Written Test should be given as a pretest so that identified competencies can be accurately measured.

- Use the section in the Upfront to assist you in assessing student competencies.

- Consider the pretest results as you prepare your presentation for each objective.

DELIVERY

Unit introduction

- Discuss introduction to the unit. (See Objective Sheet.)

- Discuss the Unit Objective and then the Specific Objectives. Emphasize how accomplishing the Specific Objectives will lead to meeting the Unit Objective and how reaching the unit objective is vital to becoming an Automotive Brakes Specialist. Also relate the objective to your introduction and to materials previously covered.

- Show the film, *Hydraulic Brake Service Overview*. Discuss with the class.

- Use Transparency 1, Hydraulic Brake System Operation, to illustrate basic hydraulic brake system operation.

- Discuss the importance of accurate diagnosis and high-quality brake service.

- Show the class sample diagnostic charts and service schedules from various service manuals. Post charts and other materials related to brake service.

- Tour the shop and point out the equipment, materials, and areas reserved for brake work.

Objective 1: Recognize definitions of terms associated with the brake hydraulic system by choosing the correct definition from lists of three choices.

- Show examples of terms where applicable.

- Show samples of the various classes of brake fluids.

- Discuss health-related terms in more detail when you cover Objective 9.

Objective 2: Label the basic components of a hydraulic brake system indicated on an illustration.

- Show the students the actual components on various makes and models of vehicles. Point out differences in types of master cylinders, brake valves, line configurations, and brake types.

- Discuss the functions of each component, pointing out design features that facilitate function.

- Display components on a table in the shop. Encourage students to handle and examine each component.

- Pair students and have teams quiz each other on the names and locations of the components.

- Show the slide presentations, *Brake Hydraulics* and *Theory of Hydraulics*.

Objective 3: List the steps of hydraulic brake operation in order.

- Review hydraulic principles such as Pascal's Law, coefficient of friction, power, energy, force and motion, tire traction, etc.

- Build a mock-up to illustrate the sequence of hydraulic brake operation.

- Use Transparency 1, Hydraulic Brake System Operation, to illustrate your discussion of hydraulic brake operation.

- Show the filmstrip, *Hydraulic Brake Service Overview*.

Objective 4: Define the characteristics of good brake fluid.

- Discuss the characteristics listed in this objective.

- Demonstrate applicable properties or characteristics. For example, place a container of brake fluid in the refrigerator and then demonstrate its viscosity or flowability at low temperatures.

- Discuss the boxed material, *Types of Brake Fluid*.

- Show the students samples of the three types of DOT brake fluid. Discuss the differences in each type.

Objective 5: Recognize guidelines for handling and storing brake fluid.

- Review each of the guidelines listed in this objective, explaining the reasons for each.

- Use a painted piece of scrap metal to demonstrate the effects of spilling brake fluid on a painted surface.

- Discuss the boxed material, *More About Brake Fluids*, explaining its application to the guidelines listed.

- Demonstrate how brake fluid absorbs moisture from the air and how this absorption lowers the boiling point of the fluid. Use three containers of brake fluid: one just opened, one left open to the air overnight, and one left open to the air for one or two days. Carefully heat each container of fluid over an electric burner, measuring the length of time it takes each to boil.

  CAUTION

  Do not use an open flame to heat the fluids, and do not spill any of the fluid near an electric burner. Brake fluid is flammable. Turn off heat as soon as fluid reaches boiling point.

- Have students read the cautions and instructions for use on the labels of various types of brake fluid.

Objective 6: Complete statements describing hydraulic lines and fittings.

- Show the students examples of various hydraulic lines and fittings.

- Slice a brake hose lengthwise to expose its plies and to show students how hose fittings are designed to grip both the inside and outside of the hose.

- Display various male and female hose and line fittings.

- Demonstrate installation of both a double flared fitting and an ISO flared fitting, pointing out the similarities and differences between the two.

- Demonstrate the proper tools and methods for removing and installing lines and fittings.

- Combine this with the next objective by showing students how to shape lines with a lever-type tubing bender.

Objective 7: Determine the correct specialty tool to use to service the hydraulic system and wheel bearings.

- Show the students an example of each of the tools listed in this section of the information sheet.
- Demonstrate the use of each of the tools, allowing each student to repeat the demonstration.
- Where applicable, show the students alternative tools or methods that can be used to accomplish a task.

Objective 8: Complete drawings of the hydraulic circuits for dual braking system designs.

- Show the students examples of both designs on various vehicles.
- Explain the advantages and disadvantages of the two designs.

Objective 9: Evaluate asbestos safety practices.

- Provide the students with copies of Extensions and Options 1, Preventing Asbestos Disease among Auto Mechanics, and any updates on this subject. Discuss the supplement in class and hold a question-and-answer session to resolve any student misunderstanding or misconceptions.

  NOTE: The boxed material with this objective, comes directly from the material presented in Extensions and Options 1, Preventing Asbestos Disease among Auto Mechanics. If you choose not to provide the students with Extensions and Options 1, discuss this material thoroughly and answer any student questions.

- Show the video, *Don't Blow It.*
- Review and explain each asbestos safety practice outlined in this section of the information sheet.
- Show the students a HEPA-type vacuum filter.
- Show the students an enclosure-type brake cleaner and demonstrate its installation and use. Emphasize that the installation sequence must be adhered to strictly.

- Follow EPA's asbestos disposal guidelines in your shop and make sure that each student is aware of these guidelines.

- Post asbestos safety guidelines in your shop and appropriately discipline any student who disregards the guidelines.

- Invite a former Automotive Service Specialist whose health has been damaged by asbestos inhalation to speak to the class on the dangers of asbestos contamination.

- Make sure that your shop environment meets EPA and OSHA regulations regarding equipment and exhaust systems. If you have not already done so, set aside an area in the shop for brake work only. Monitor students carefully and set high safety standards.

- Explain your laundering procedures to the students. Walk them through the complete routine for washing hands, face, and exposed skin and changing clothes at the end of each class period.

Objective 10: Match terms associated with wheel bearings to their definitions.

- Show the students examples of each of the terms listed in this objective.

- Demonstrate *bearing end play*, *press fit*, *push fit*, and *preload*.

- Display a complete bearing assembly with the parts named.

- Discuss the boxed material, *Wheel Bearings*.

Objective 11: Identify types of wheel bearings shown in illustrations.

- Show the students samples of each bearing type.

- Discuss the similarities and differences in bearing types and the reason for manufacturers using one type over another.

- Display the various bearing types on a table in the shop or classroom.

- Combine this objective with Objective 12 and discuss the purposes of wheel bearings as you show the students the different types.

Objective 12: List the purposes of wheel bearings.

- Combine this objective with Objective 11, explaining the purposes of each type of wheel bearing given.

- Demonstrate how wheel bearings reduce friction. Show the students how much resistance there is when sliding a heavy object across a surface compared to sliding the same object across the surface on a handful of marbles.

- Discuss the boxed material, *Wheel Bearings and Load Lines.*

Objective 13: Label the parts of a tapered roller wheel bearing indicated on an illustration.

- Use Transparency 2, Tapered Roller Wheel Bearing, to illustrate your discussion.

- Display a tapered roller wheel bearing assembly so that the students may examine its components.

- Disassemble a tapered roller wheel bearing assembly, naming and explaining each of the parts as it is disassembled.

- Discuss the boxed material, *Wheel Bearing Noises.*

Objective 14: Recognize properties of wheel bearing grease.

- Review each of the properties listed in this objective, explaining the reasons for these properties.

- Have the students read the labels on various brands of wheel bearing grease. Discuss.

- Demonstrate each of the properties. For instance, show how wheel bearing grease is heat-resistant, water-resistant, and noncorrosive.

- Discuss the boxed material, *Wheel Bearing Lubrication.*

- Show the videos, *Clean and Inspect Bearings, Pack Front-Wheel Bearing Assembly,* and *Adjust Front-Wheel Bearings,* from *Service Brake Hydraulic System and Wheel Bearings.*

Objective 15: Label the parts of a dual master cylinder indicated on an illustration.

- Show the students examples of various types of dual master cylinders.
- Disassemble a typical master cylinder, naming and explaining the parts as it is disassembled.
- Discuss the functions of each of the parts of a typical master cylinder and explain the differences in reservoir size and design.

Objective 16: Match the names and functions of combination valve components to an illustration.

- Show the students an example of a combination valve, pointing out each component and explaining its function.
- Show the students the location of the combination valve on various makes and models of vehicles.
- Show the students a vehicle that does not combine the brake valves in one unit. Make sure that students can identify each valve.
- Discuss the boxed material, *Functions of the Combination Valve*.
- Use Transparencies 3 through 5 to illustrate your discussion of valve operation.

Objective 17: Label types of power-assist units shown in illustrations.

- Discuss power-assisted braking in general, tracing the evolution of this system and explaining the need for power-assisted braking on larger and heavier vehicles.
- Show the students examples of each type of power-assist unit on various makes and models of vehicles.
- Discuss the differences in design and operation among the units.

Objective 18: Label the parts of a vacuum power-assist unit indicated on an illustration.

- Use Transparency 7, Operation of Vacuum-Suspended Power-Assist Unit, to explain the operation of this type of power-assist unit.

- Show the students a vacuum power-assist unit on a vehicle, pointing out and explaining its components.

- Display a mock-up or cutaway vacuum power-assist unit, so that students may examine the internal components of the unit.

- Disassemble a vacuum power-assist unit, explaining each component and its function as you come to it.

Objective 19: Label the major parts of a hydraulic power-assist unit (mechanical pump) indicated on an illustration.

- Use Transparency 8, Operation of Hydraulic Power-Assist Unit (Mechanical Pump), to explain the operation of this type of power-assist unit.

- Show the students a hydraulic power-assist unit (mechanical pump) on a vehicle, pointing out and explaining its components. Show students units with both integral and separate accumulators.

- Display a mock-up or a cutaway hydraulic power-assist unit (mechanical pump), so that students may examine the internal components of the unit.

- Disassemble a hydraulic power-assist unit, explaining each component and its function as you come to it.

Objective 20: Label the major parts of a hydraulic power-assist unit (electrical pump) indicated on an illustration.

- Use Transparency 9, Operation of Hydraulic Power-Assist Unit (Electrical Pump), to assist you in explaining the operation of this type of power-assist unit.

- Show the students a hydraulic power-assist unit (electrical pump) on a vehicle, pointing out and explaining its components.

- Display a mock-up or cutaway hydraulic power-assist unit (electrical pump), so that students may examine the internal components of the unit.

- Disassemble a hydraulic power-assist unit (electrical pump), explaining each component and its function as you come to it.

APPLICATION

DIAGNOSIS SKILLS

Diagnosis is the highest level of competence in automotive service. Any type of automotive diagnosis requires that the technician possess both extensive knowledge and considerable practical skill. In this series, the Assignment Sheets are designed to help the student learn the diagnostic skills involved in using troubleshooting procedures and diagnostic charts commonly found in vehicle service manuals. These skills are only part of the total requirement for diagnostic excellence.

We recognize that a good diagnosis cannot be made without the practical knowledge the student will learn from performing the Job Sheet tasks. At the same time, the Job Sheet procedures should not be performed unless the necessity for them is indicated by a proper diagnosis. You will need to analyze your teaching techniques and decide whether to have your students do the Assignment Sheets before the Job Sheets for vice versa. For students who are newly learning these skills, there are pitfalls to both sequences.

Objective 21: Diagnose brake system hydraulic and wheel bearing problems. (Assignment Sheet 1)

- Have the students use Supplements 1, 5, 6, and 7 to complete Assignment Sheet 1.

Objective 22: Diagnose power-assist unit problems. (Assignment Sheet 2)

- Have the students use Supplements 2, 3, and 4 to complete Assignment Sheet 2.

Objective 23: Inspect, test, and service hydraulic brake lines and hoses. (Job Sheet 1)

- Show the students how to read a pressure gauge and how to read vacuum pressure specification charts in service manuals.

- Show the video, *Test the Hydraulic System*, from *Service Brake Hydraulic System and Wheel Bearings.*

- Discuss the correct use of an inspection report form such as Extensions and Options 2, Brake System Inspection Report Form, and provide the students with copies to use when practicing inspection procedures.

- Discuss the equipment and materials used in Job Sheet 1.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.

- Demonstrate Job Sheet 1.

- Have the students practice Job Sheet 1 until they are ready to take the Practical Test.

Objective 24: Bleed or flush a hydraulic braking system. (Job Sheet 2)

- Show the video, *Bleed Brake Systems*, from *Service Brake Hydraulic System and Wheel Bearings.*

- Discuss the equipment and materials used in Job Sheet 2.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.

- Demonstrate Job Sheet 2.

- Have the students practice Job Sheet 2 until they are ready to take the Practical Test.

Objective 25: Remove, clean, inspect, and repack (or replace and pack) wheel bearings and replace seals. (Job Sheet 3)

- Show the video, *Clean and Inspect Bearings* and *Pack Front Wheel Bearing Assembly*, from *Service Brake Hydraulic System and Wheel Bearings.*

- Discuss the equipment and materials used in Job Sheet 3.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.
- Demonstrate Job Sheet 3.
- Have the students practice Job Sheet 3 until they are ready to take the Practical Test.

Objective 26: Adjust wheel bearings. (Job Sheet 4)

- Show the video, *Adjust Front-Wheel Bearings*, from *Service Brake Hydraulic System and Wheel Bearings.*
- Discuss the equipment and materials used in Job Sheet 4.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.
- Demonstrate Job Sheet 4.
- Have the students practice Job Sheet 4 until they are ready to take the Practical Test.

Objective 27: Remove and replace front-wheel drive nonserviceable sealed wheel bearings. (Job Sheet 5)

- Discuss the equipment and materials used in Job Sheet 5.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.
- Demonstrate Job Sheet 5.
- Have the students practice Job Sheet 5 until they are ready to take the Practical Test.

Objective 28: Remove and replace a dual master cylinder. (Job Sheet 6)

- Show the video, *Remove, Repair, and Replace a Tandem Master Cylinder*, and *Rebuilding a Dual Piston Master Cylinder* from *Service Brake Hydraulic System and Wheel Bearings.*

- Discuss the equipment and materials used in Job Sheet 6.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.
- Demonstrate Job Sheet 6.
- Have the students practice Job Sheet 6 until they are ready to take the Practical Test.

Objective 29: Remove and replace a take-up valve in a quick take-up master cylinder. (Job Sheet 7)

- Discuss the equipment and materials used in Job Sheet 7.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.
- Demonstrate Job Sheet 7.
- Have the students practice Job Sheet 7 until they are ready to take the Practical Test.

Objective 30: Overhaul a master cylinder. (Job Sheet 8)

- Discuss the equipment and materials used in Job Sheet 8.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.
- Demonstrate Job Sheet 8.
- Have the students practice Job Sheet 8 until they are ready to take the Practical Test.

Objective 31: Bench bleed a master cylinder. (Job Sheet 9)

- Discuss the equipment and materials used in Job Sheet 9.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.

- Demonstrate Job Sheet 9.

- Have the students practice Job Sheet 9 until they are ready to take the Practical Test.

Objective 32: Remove and replace a combination valve. (Job Sheet 10)

- Show the filmstrip, *Hydraulic Brake Service Overview*.

- Discuss the equipment and materials used in Job Sheet 10.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.

- Demonstrate Job Sheet 10.

- Have the students practice Job Sheet 10 until they are ready to take the Practical Test.

Objective 33: Remove, adjust, and replace a load-sensing proportioning valve. (Job Sheet 11)

- Discuss the equipment and materials used in Job Sheet 11.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.

- Demonstrate Job Sheet 11.

- Have the students practice Job Sheet 11 until they are ready to take the Practical Test.

Objective 34: Check and adjust brake stop light and warning light systems. (Job Sheet 12)

- Use Transparency 6, Stop Light Switch Designs, Extensions and Options 3, Warning Light Switch Operation, and Supplement 8, Diagnostic Chart for Stop Lights, to assist you in discussing warning and stop light switch operation.

- Discuss the equipment and materials used in Job Sheet 12.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.

- Demonstrate Job Sheet 12.

- Have the students practice Job Sheet 12 until they are ready to take the Practical Test.

Objective 35: Inspect a vacuum power-assist unit and check valve for leaks and proper operation. (Job Sheet 13)

- Show the video, *Test Vacuum Booster* from *Service Brake Hydraulic System and Wheel Bearings.*

- Discuss the equipment and materials used in Job Sheet 13.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.

- Demonstrate Job Sheet 13.

- Have the students practice Job Sheet 13 until they are ready to take the Practical Test.

Objective 36: Inspect a hydraulic power-assist unit (mechanical pump) for leaks and proper operation. (Job Sheet 14)

- Discuss the equipment and materials used in Job Sheet 14.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.

- Demonstrate Job Sheet 14.

- Have the students practice Job Sheet 14 until they are ready to take the Practical Test.

Objective 37: Test, remove, and install a hydraulic power-assist unit (mechanical pump). (Job Sheet 15)

- Discuss the equipment and materials used in Job Sheet 15.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.
- Demonstrate Job Sheet 15.
- Have the students practice Job Sheet 15 until they are ready to take the Practical Test.

Objective 38: Inspect and overhaul a hydraulic power-assist unit (electrical pump). (Job Sheet 16)

- Discuss the equipment and materials used in Job Sheet 16.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet introduction with the students.
- Demonstrate Job Sheet 16.
- Have the students practice Job Sheet 16 until they are ready to take the Practical Test.

EVALUATION

- Give Written Test.

  NOTE: The Written Test may be given in sections if desired.

- Many multiple-choice test questions (in the Activity Sheets, Assignment Sheets, and Written Test) for this curriculum have been written in a style that is similar to the questions on the ASE certification test. Like ASE questions, the student should select the item that **BEST** answers the question. *The student should make no additional assumptions about a question other than those specifically given in the question.* A special effort has been made to provide good distracters for each question which will make the student think through the answer. It is suggested that the instructor review the answers to every test before reviewing the test with the students so that he or she is not caught off guard by such distracters.
- Evaluate the class on the Assignment Sheet activities if not previously done.

- Give the Practical Test, providing students with copies of Extensions and Options 2, Brake System Inspection Report Form, or a similar form to be completed as part of the Practical Tests. Evaluate the tests on the forms provided.

- Reteach and retest as required.

- The Activity Sheet may be given at the end of the unit as a review and a preview of the ASE test style.

- Complete the appropriate section of the Competency Profiles.

- Review individual and group performance in order to evaluate teaching methods.

- Adjust the scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Resources used in developing unit

- *Automotive Brake Service, Unit 1: Brake Inspection and Diagnosis.* Tallahassee, Florida: State of Florida Department of Education, 1981.

- *Automotive Brake Service, Unit 2: Front Disc Brake Service.* Tallahassee, Florida: State of Florida Department of Education, 1981.

- *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service.* Tallahassee, Florida: State of Florida Department of Education, 1981.

- *Bendix Service Manual 8-400: Domestic and Import Car Brake Service Manual.* Jackson, Tennessee: Bendix Aftermarket Brake Division, n.d.

- Billiet, Walter E., and Walter Alley. *Automotive Suspensions, Steering, Alignment, and Brakes*, 5th ed. Alsip, Illinois: American Technical Publishers, Inc., 1982.

- *Brake Systems: Student Reference Book.* Centerline, Michigan: Chrysler Corporation Service and Parts Operations, Training Program Development Department, 1984.

- *Chilton's Auto Repair Manual 1985: Domestic and Canadian Cars from 1978 through 1985.* Radnor, Pennsylvania: Chilton Book Company, 1984.

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Media

Spelling and definitions of terminology used in automotive service are not standardized. Media selected to supplement and reinforce materials taught in this book may or may not use the same spelling and definitions. Although such deviations should not restrict classroom use of supplemental materials, its existence may confuse some students.

- *Theory of Hydraulics.* Slide/tape, 15 minutes. Dana Corporation, School Assistance Program, P.O. Box 455, Toledo, Ohio 43629. This program describes the concepts of flow, pressure, and force in a hydraulic system.

- *Brake Hydraulics* (AU-911). 83 slides with a 15-minute audiotape. Wagner Division, McGraw-Edison Company, 6400 Plymouth Avenue, St. Louis, Missouri 63133. This program explains how hydraulics is used in both drum and disc brake systems.

- *Hydraulic Brake Service Overview.* 12 minutes, color filmstrip and cassette. Prentice-Hall Media, ServCode DU, 150 White Plains Road, Tarrytown, New York 10591. This filmstrip shows the components of a typical hydraulic brake system, explains the operation of the system, discusses some recommended safety checks, and discusses the combination valve in some detail.

- *Rebuilding a Dual Piston Master Cylinder.* 14 minutes, color filmstrip and cassette. Prentice-Hall Media, ServCode DU, 150 White Plains Road, Tarrytown, New York 10591. This filmstrip identifies components and their functions, shows how they are removed and replaced, and includes overhauling procedures.

NOTE: The following two videotapes are available to Oklahoma teachers on a free-loan basis. Out-of-state teachers must order from the addresses listed.

- *Service Brake Hydraulic System and Wheel Bearings* containing the following: "Test the Hydraulic System"; "Bleed Brake System"; "Clean and Inspect Bearings"; "Pack Front-Wheel Bearing Assembly"; "Adjust Front-Wheel Bearings"; "Remove, Repair, and Replace Tandem Master Cylinder"; and "Test Vacuum Booster." VHS videotapes. Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

- *Don't Blow It.* 16 minutes, VHS videotape. Available for loan or purchase from Clayton Associates, Inc., P.O. Box 589, Farmingdale, New Jersey 07727-0589, phone (800) 248-8650. This videotape demonstrates the proper way to use asbestos-removal equipment to prevent asbestos exposure.

Print media

For the most recent information on asbestos safety for the brakes specialist, write to the following addresses:

- EPA Region VI
  Internfirst II Bldg.
  1201 Elm Street
  Dallas, Texas 75270
  (214) 767-2734

- National Institute for Occupational Safety and Health
  4676 Columbia Parkway
  Cincinnati, Ohio 45226
  (513) 533-8323

- OSHA Office of Information and Consumer Affairs, Rm N-3637
  200 Constitution Avenue N.W.
  Washington, D.C. 20210
  (202) 523-8151

- *Introduction to Automotive Mechanics, Unit 2: Lubrication, Cooling, and Safety Inspection Services.* Tallahassee, Florida: Florida Department of Education, 1986.

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PREVENTING ASBESTOS DISEASE AMONG AUTO MECHANICS

I. MECHANICS' EXPOSURE TO ASBESTOS:

Friction materials, such as brake linings and clutch facings, often contain asbestos. Millions of asbestos fibers can be released during brake and clutch servicing (*Ref. 1-8*). Grinding and beveling friction products can cause even higher exposures (*Ref. 1-8*). Like germs, asbestos fibers are small enough to be invisible, and they can remain and accumulate in the lungs. When you see a dust cloud during brake work, you are seeing clumps containing thousands of fibers. Most of the smaller fibers will not show up with the methods commonly used for measuring asbestos levels in the air, such as the method used to determine compliance with the OSHA asbestos standard, since most asbestos fibers in brake dust are too small to be measured by these methods (*Ref. 1-3, 5-8*).

Asbestos released into the air lingers around a garage long after a brake job is done and can be breathed in by everyone inside the garage, including customers. While lowering exposure lowers risk, there is no known level of exposure to asbestos below which health effects do not occur (*Ref. 9-12*). The EPA has proposed phasing out the use of asbestos products. In situations where asbestos exposures cannot be eliminated entirely, they should be reduced to the lowest possible level (*Ref. 9, 13*).

Asbestos can be carried on work clothing, contaminating the family car and home. This can cause asbestos disease among family members. An ordinary house vacuum cleaner cannot collect these asbestos fibers, since its filter is not fine enough to trap them. In fact, an ordinary house vacuum cleaner is likely to stir these fibers up and scatter them into the air.

Asbestos can also get on a mechanic's hands and be swallowed when eating or smoking a cigarette. This is a

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particularly difficult problem for mechanics, since they often get grease on their hands and asbestos fibers can stick to the grease.

II. HEALTH EFFECTS OF ASBESTOS EXPOSURE:

Until the use of asbestos products is phased out, the best way of limiting health damage to workers exposed to asbestos is to use proper controls. It is not possible to predict whether an individual person exposed to asbestos will later develop asbestos-related disease. But studies of disease patterns among large groups of workers exposed to asbestos make general observations possible. The following can be the consequences of inadequate prevention:

Asbestosis

Asbestos exposure can cause scar tissue to form in the lungs. This is a very gradual process that usually takes many years before its effects are noticed. This scarring is called asbestosis. It causes gradually increasing shortness of breath. A person with this disease must breathe harder and deeper to get his or her breath because the scar tissue makes it harder for oxygen to get into the blood stream. This scarring is caused by repeated exposures to asbestos and is permanent. Nearly one-half of the mechanics who work for many years without proper control measures can develop this scarring (*Ref. 7, 14*).

Cancer

1. Mesothelioma

   Mesothelioma is a type of fatal cancer of the lining of the chest or abdominal cavity. It can be caused by very low exposures to asbestos. This cancer has occurred among brake mechanics (*Ref. 15-20*), their wives (*Ref. 20*), and their children (*Ref. 21*).

2. Lung Cancer

   Lung cancer is currently responsible for the largest number of deaths from exposure to asbestos (*Ref. 22*). Even short-term occupational exposures have been shown to increase the risk of lung cancer. Like asbestos,

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smoking can independently cause lung cancer, increasing the risk by about 10 times. When smokers are exposed to asbestos, the risks do more than add together; they actually multiply. For example, asbestos insulators who smoke have a lung cancer risk over 50 times higher than nonsmokers without asbestos exposure. However, stopping smoking greatly reduces this risk, even if a person has smoked for many years. Smokers who have been exposed to asbestos should be especially encouraged to stop smoking. The extent of risk of lung cancer among mechanics is not now known; but, given the known lung cancer risk among other groups exposed to asbestos, caution is necessary.

3. Other Cancers

   Other cancers which appear to be caused by asbestos include cancer of the voice box (*Ref. 25, 26*) and of the stomach and large intestine (*Ref. 27, especially page 315*).

Latency Period

It usually takes 15 to 30 years or more for cancer or asbestos lung scarring to show up after exposure. (Scientists call this the *latency period.*) Until then, the victim often feels fine. This gives a false sense of security. For example, if one touches a hot stove, one gets burned right away. With asbestos, the damage isn't obvious until many years later. This false sense of security can easily lead a worker and/or supervisor to follow work practices that can cause harmful exposures, since they are not aware that disease may develop later.

III. MEDICAL TESTS:

Medical tests only discover asbestos-related disease after it has developed. In some cases, where the condition may be curable, especially with asbestos-related cancers of the large intestine and voice box, early detection can be very important.

Asbestosis

Asbestosis, or lung scarring from asbestos, is permanent and cannot be treated. It is diagnosed by chest X rays,

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breathing tests (called *lung* or *pulmonary function tests*), and/or listening to the lungs, together with a history of exposure to asbestos. Very early asbestosis may be missed by these techniques. Early asbestosis is difficult to see on a chest X ray and is best evaluated by a doctor who has experience and/or specialized training with asbestosis. (This type of specialist is called a "B reader" of X rays.)

Lung Cancer

Very often lung cancer from asbestos has already spread by the time it can be seen on a chest X ray or by tests of the phlegm. This is why more frequent tests for lung cancer do not help the average person who develops this cancer to live longer. Lung cancer is thus a condition needing prevention more than early detection and cure.

Intestinal Cancer

Cancer of the large intestine can often be detected early by yearly exams of the rectum and sigmoid area, with a hemoccult test for blood in the stool. Early detection and treatment of this condition can result in cure.

Voice Box Cancer

Voice box cancer can often be discovered at a curable stage by a medical exam. It may show up as hoarseness that does not go away in a few weeks.

IV. EXTENT OF EXPOSURE DURING BRAKE/CLUTCH MAINTENANCE:

Using a compressed-air hose to clean drum brakes can release up to 16 million asbestos fibers in the cubic meter of air around a mechanic's face (*Ref. 1*).* Even hitting a brake drum with a hammer can release over a million asbestos fibers (*Ref. 4*). Much less dust from asbestos-lined disc brake pads will settle on disc brakes, but some dust can get on a mechanic's hands and into the garage air during maintenance. The asbestos fibers released from brake and clutch work can be scattered throughout a garage, where they can present a

* These are the larger fibers measured by common methods for counting asbestos fibers. The very small ones are far more numerous, but can be seen with the electron microscope.

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hazard for months or years. Because of this, many garages are now turning to newer methods for brake cleaning. However, some of these newer methods may actually contribute to the problem. For example, millions of asbestos fibers can be released from drum brakes with these methods:

- Wiping with a dry rag or brush (*Ref. 1-3*).

- Wiping with a wet rag or brush (*Ref. 2, 3*). The water doesn't prevent scattering of much of the asbestos, and when the rag dries or is shaken, asbestos is spread around the garage.

- Liquid squirt bottles or solvent sprays (*Ref. 3*). The water or solvent under pressure scatters much of the asbestos, and when it dries the asbestos is still all over the surrounding work surfaces. Brake-cleaning equipment using these methods with a brush or squirt gun is likely to have the same problems. In fact, measurements from one manufacturer using a liquid spray system showed that over a million fibers can be released near a mechanic's face (*Ref. 28*). Using a specially designed low-pressure spray and properly collecting and disposing of contaminated liquid may prevent some asbestos from spreading around the garage. Some recirculating wet-method equipment uses a solvent to collect brake dust into a tray. If the solvent evaporates from the tray, normal air currents easily lift the asbestos fibers back into the air.

- Using a garden hose may prevent some brake dust from becoming airborne, but this can easily contaminate the garage floor or other work areas by scattering the asbestos.

- Using a standard shop vacuum cleaner. A shop vacuum cleaner can spread asbestos about a garage as much as does a compressed-air hose. (*Ref. 6: Using a shop vacuum cleaner raised asbestos concentrations in adjacent bays to levels greater than those found using a compressed-air hose.*) A shop vacuum cleaner filter is not fine enough to collect asbestos fibers.

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All of these brake-cleaning methods can release enough asbestos into a garage (*Ref. 6, 29*) so that an average of over one million of the larger fibers could be breathed each day by workers in that garage. These brake-cleaning methods can also cause customers to be exposed, since asbestos from brake work can be spread 75 feet away from the mechanic (*Ref. 1*).

When grinding is done to renew used brake block linings, concentrations of up to 7 million asbestos fibers per cubic meter can be released. Bevelling new linings can release concentrations of up to 72 million fibers and light grinding of new linings of up to 4.8 million fibers (*Ref. 7*).

V. CONTROLLING EXPOSURES:

NIOSH, OSHA, and EPA recommend that where asbestos exposures cannot be eliminated, they must be controlled to the lowest level possible (*Ref. 9, 13*). Effective containment prevents problems associated with housekeeping and with stirring up settled dust (*Ref. 13*). The best approach is to contain brake dust and prevent its release into a garage.

Brake Cleaning

Enclosure equipment for brake cleaning is available, which slips easily over the brake assembly and forms a tight seal against the backing plate. A compressed-air system can then be used inside this type of enclosure system for good brake cleaning without exposing the brake mechanic or others. Clear plastic walls or windows allow easy visibility of the work being done. Brake dust is sucked into a vacuum cleaner equipped with a special filter called a HEPA or "high-efficiency particulate air" filter. Only this type of filter can capture the small, invisible asbestos fibers. Nonpermeable glove attachments on some equipment allow a mechanic to do work inside the enclosure without getting asbestos on the hands. If glove attachments are available only as an option, this option should be selected.

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How To Use Enclosure Equipment for Cleaning Drum Brakes

Steps for using this type of equipment on drum brakes are simple:

1. Check that the hose is securely fastened to the HEPA vacuum container and to the brake enclosure. Also check that the vacuum container seals and clips are in proper functioning order according to the manufacturer's instructions.
2. Remove the wheel.
3. Turn on the asbestos vacuum cleaner.
4. Place the enclosure over the drum, making sure it forms a tight seal behind the backing plate.
5. Place hands into the attached rubber gloves.
6. Remove the brake drum. Some equipment allows use of a hammer or other tools inside the enclosure for drums that are hard to remove.
7. Blow dust off the drum and brake assembly, using the air gun attachment inside the enclosure.
8. Blow dust off all inside surfaces of the enclosure towards the vacuum exit, using the air gun attachment inside the enclosure.
9. Remove the enclosure and turn off the vacuum cleaner.

If grease accumulates on the inside surfaces of the enclosure, clean according to the manufacturer's instructions with a soft cloth and with the vacuum running. Dispose of the cloth according to OSHA regulations (*Ref. 30*). This cloth should not be handled with bare hands.

Disc Brakes

For disc brakes, vacuum the pads, rotor, and caliper directly with a crevice attachment and avoid handling them before vacuuming.

Filter Change and Waste Disposal

Asbestos vacuum cleaners have several filters. Changing filters and disposing of asbestos waste can release dangerous concentrations of asbestos unless done properly. Some equipment allows for filter or collection bag change while the vacuum motor is running. This draws loose brake dust into the vacuum collector and away from the mechanic, reducing the risk of exposure.

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Some equipment has a renewable main filter that can be cleaned repeatedly without opening the vacuum cleaner. Ideally, all vacuum equipment should be designed to prevent opening the vacuum chamber when the vacuum motor is turned off, since opening the chamber can cause release of collected asbestos into the air. Always follow the manufacturer's instructions for filter or collection bag change. Request a demonstration and practice session from the manufacturer to go through all steps for equipment use and filter or collection bag change, until each person who is to use this equipment is completely familiar with these procedures. Place the filter or collection bag directly into a 6-mil. (heavy) plastic bag and double tie. Place the bag directly into a 55-gallon drum or similar leakproof, airtight container designated for asbestos waste according to OSHA regulations (*Ref. 30*) and mark it as follows:

CAUTION
Contains Asbestos Fibers
Avoid Breathing Dust
Breathing Asbestos Dust Can Cause
Lung Disease and Cancer

Keep this drum for asbestos waste locked between filter or collection bag changes. Transport and disposal of asbestos waste should be done only by individuals familiar with procedures for handling asbestos waste in accordance with EPA's asbestos-disposal guidance (*Ref. 31*).

Clutch Repair

Significant exposure can also occur during clutch repair. Since a mechanic's head is typically under the clutch assembly during clutch repair, asbestos often falls on a mechanic's face and clothing. Enclosure equipment with a HEPA vacuum cleaner to prevent this exposure is under development.

Non-Asbestos Brake Linings

The use of non-asbestos friction materials is increasing. Available information suggests that none of these substitute materials is as dangerous as asbestos. Unless a mechanic is certain before brake work starts that a

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particular vehicle's brakes are not lined with asbestos, it should be assumed for the sake of caution that there is asbestos in the brake dust. In addition, friction materials often contain adhesives, toxic metals, and other hazardous chemicals that can harm the body (*Ref. 2*). Thus, even for non-asbestos friction products, an enclosure system can control exposures to materials that may be harmful.

What to Look for in Enclosure Equipment for Brake Cleaning

Recommended features to look for in selecting enclosure equipment include:

1. Features which prevent hand contact with asbestos, including rubber (or other non-permeable) gloves to cover both hands. Look for attached gloves with no spaces for leakage. If attached gloves are not standard with the equipment, they should be selected as an option.
2. Enclosures large enough to fit around the biggest size brake drums likely to be encountered to prevent exposure during drum removal.
3. Reports of air sampling with analysis by transmission electron microscopy that show no release of asbestos fibers when using the equipment during brake maintenance. This helps ensure against design defects.
4. A sturdy seal behind the backing plate to prevent leakage during blow out.
5. A pressure gauge or manometer indicating when vacuum filter change or cleaning of renewable filter is needed. This helps ensure effective suction during use.
6. Safety of filter change or renewable filter cleaning. Ideally, future models of these devices will have a feature that prevents opening the filter housing while the vacuum motor is switched off.

Enclosure system manufacturer information is discussed in *References 32-35.*

Machining and Bevelling

Whenever possible, pre-ground, installation-ready brake linings and clutch facings should be used. If friction

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materials must be arced, this should be done by lathe-turning at low speed, rather than by grinding. Linings should not be ground to fit brake systems for which they were not designed. Where friction materials must be machined, bevelled, or lathe-turned, adequate local exhaust ventilation equipment connected to a HEPA vacuum collector should be used to prevent mechanic exposure and shop contamination. Such equipment should be designed and set up by a professional ventilation engineer, using specifications such as those found in the American Conference of Governmental Industrial Hygienists' ventilation manual (*Ref. 36*) as a minimum design standard. There must be a comprehensive asbestos control and monitoring program where machining, bevelling, or lathe-turning is done (*Ref. 30*).

Special Areas for Brake Work

Eating, drinking, and smoking should not be done in an area where brake work is done. Mechanics should wash their hands and face before eating and wash all exposed skin and change clothes before going home. If possible, work clothes should be laundered at special facilities equipped to wash clothing contaminated with asbestos. Smokers should be urged to quit and, if necessary, be provided assistance in entering a smoking-cessation program.

VI. RESPIRATORS:

The National Institute for Occupational Safety and Health (NIOSH) recommends the use of engineering controls and good work practices as the primary means of reducing exposures (*Ref. 9, 13*). Proper use of a respirator specially recommended for asbestos (*Ref. 37*) when using the brake-cleaning methods described in Part IV of this guidance can only protect a mechanic while the respirator is being worn. Since any of the brake-cleaning methods described in Part IV could contaminate a garage with brake dust, mechanics and other employees would have to wear such a respirator all day to be protected. In addition, effective respirator use requires a complete respiratory protection program, including worker training, medical evaluations, proper respirator selection and maintenance, fit testing, and periodic inspections.

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Furthermore, NIOSH and EPA recommend only certain air-supplied respirators for asbestos exposure (*Ref. 37*). These respirators could be very cumbersome in a garage setting. Air-purifying respirators with HEPA cartridges may be appropriate for secondary protection during floor cleaning, filter or collection bag changing, and waste disposal. Air-purifying respirators with HEPA cartridges should be used only as a precaution against the accidental disturbance of asbestos, and not as a substitute for effective engineering controls. It should be noted that, while NIOSH and EPA do not recommend the use of air-purifying respirators with HEPA cartridges in asbestos environments, various existing regulations currently allow their use.

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ADDITIONAL INFORMATION

This guidance was prepared to support technical materials being developed as part of the Brake Mechanic Education Program under EPA's Asbestos Action Program. The following are additional sources of information on asbestos:

EPA Regional Asbestos Coordinators:

(CT, MA, ME, NH, RI, VT)
EPA Region I
JFK Federal Building
Boston, Mass. 02203
(617) 223-0585

(DE, MD, PA, VA, WV)
EPA Region III
Curtis Building
6th and Walnut Streets
Phila., Pa. 19106
(215) 597-9859

(AL, FL, GA, KY, MS,
NC, SC, TN)
EPA Region IV
345 Cortland St., N.E.
Atlanta, Ga. 30365
(404) 881-3864

(IL, IN, MI, MN, OH, WI)
EPA Region V
230 S. Dearborn St.
Chicago, Ill. 60604
(312) 886-6003

(AR, LA, NM, OK, TX)
EPA Region VI
Internfirst II Bldg.
1201 Elm Street
Dallas, Tex. 75270
(214) 767-2734

(NJ, NY, PR, VI)
EPA Region II
Woodbridge Avenue
Edison, N.J. 08837
(201) 321-6668

(IA, KA, MO, NE)
EPA Region VII
726 Minnesota Ave.
Kansas City, Kans. 66101
(913) 236-2835

(CO, MT, ND, SD, UT, WY)
EPA Region VIII
One Denver Place
999 18th St., Suite 1300
Denver, Colo. 80202
(303) 293-1730

(AZ, CA, HI, NV, CM,
American Samoa, Guam)
EPA Region IX
215 Fremont Street
San Francisco, Calif. 94105
(415) 974-8588

(AK, ID, OR, WA)
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1200 6th Avenue
Seattle, Wash. 98101
(206) 442-2870

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Toll-Free Numbers:

Consumer Product Safety
Commission
(800) 638-2772

For information on asbestos in consumer products or homes

NIOSH
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226
(513) 533-8323

U.S. Occupational Safety and Health Administration
OSHA Office of Information
and Consumer Affairs
Room N-3637
200 Constitution Avenue, N.W.
Washington, D.C. 20210
(202) 523-8151

Source: This is a reprint of the Environmental Protection Agency Office of Pesticides and Toxic Substances Asbestos Action, Guidance for Preventing Asbestos Disease Among Auto Mechanics, June 1986.

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BRAKE SYSTEM INSPECTION REPORT FORM

Customer name ____________________

Address ____________ Telephone number: Work ____________ Home ____________

Vehicle make ____________ Year ____________ Mileage ____________

License number ____________________

Approximate time required for service ____________________

Inspected by ____________________ Date ____________

The condition of the brake system on this vehicle is as follows:

Brake system components	**Required services**	**$ Estimate**	
		Parts	**Labor**
Disc pads	☐ Semi-metallic ☐ Conventional		
Disc caliper	☐ Recondition ☐ Replace		
Disc hardware	☐ Replace		
Disc rotor	☐ Recondition ☐ Replace		
Grease seals	☐ Replace		
Front wheel bearings	☐ Repack ☐ Replace		
Wheel cylinders	☐ Recondition ☐ Replace		
Rear brake hardware	☐ Replace		
Brake shoes	☐ Replace		
Brake drums	☐ Recondition ☐ Replace		
Parking brakes	☐ Adjust ☐ Lubricate ☐ Replace		
Power brake booster	☐ Service ☐ Replace		
Master cylinder	☐ Recondition ☐ Replace		
Brake fluid	☐ Drain old, and add new fluid		
Lines, hoses, combination valve	☐ Replace		
Stop light, warning light	☐ Replace bulb ☐ Replace switch ☐ Adjust ☐ Replace		
Other ____________			
	Total		

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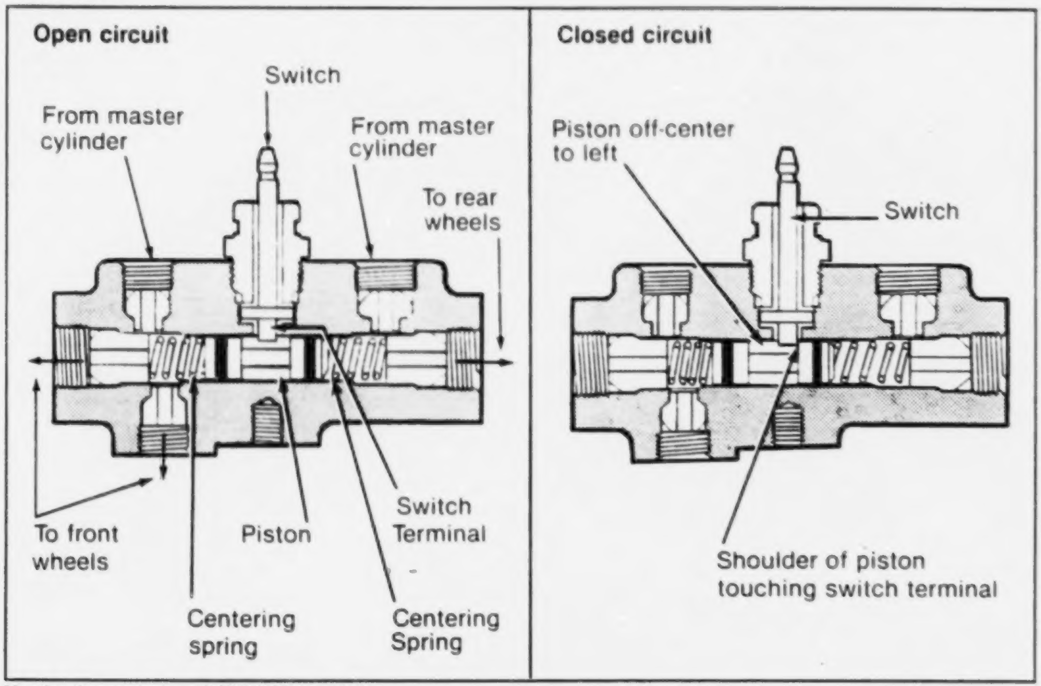
WARNING LIGHT SWITCH OPERATION

- **Switch with centering springs**

FIGURE 1


Open circuit
Switch
From master cylinder
From master cylinder
To rear wheels
To front wheels
Piston
Switch Terminal
Centering spring
Centering Spring
Closed circuit
Piston off-center to left
Switch
Shoulder of piston touching switch terminal

Used with permission of Allied Aftermarket.

Open circuit (warning light off) — Springs hold piston in centered position where it cannot touch switch terminal that projects into valve bore.

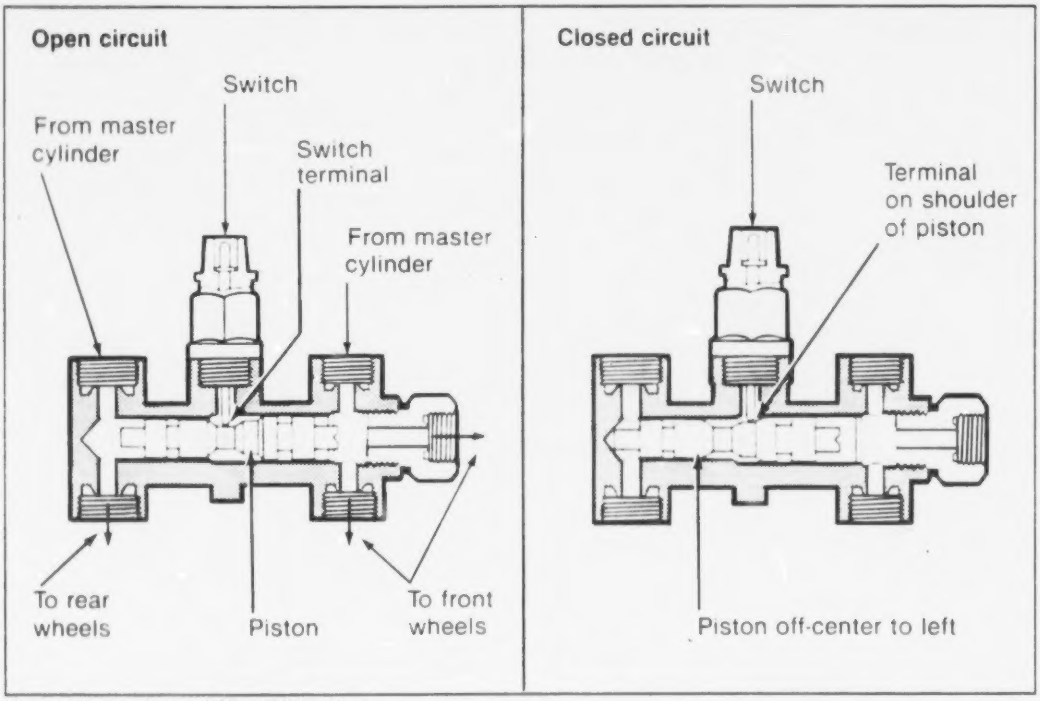
Closed circuit (warning light on) — Higher hydraulic pressure in operative side moves piston toward inoperative side of switch where piston shoulder touches switch terminal, closing the circuit and causing brake warning light to come on.

NOTE: When brakes are released and hydraulic pressure is again equal on each end of the piston, the springs recenter the piston, breaking the electrical contact, and the warning light goes out.

May be photocopied for student use.

- **Switch without centering springs**

FIGURE 2


Open circuit
Switch
From master cylinder
Switch terminal
From master cylinder
To rear wheels
Piston
To front wheels
Closed circuit
Switch
Terminal on shoulder of piston
Piston off-center to left

Used with permission of Allied Aftermarket

Open circuit (warning light off) — Equal hydraulic pressure on each end of piston holds it in centered position where it cannot touch switch terminal that projects into valve bore.

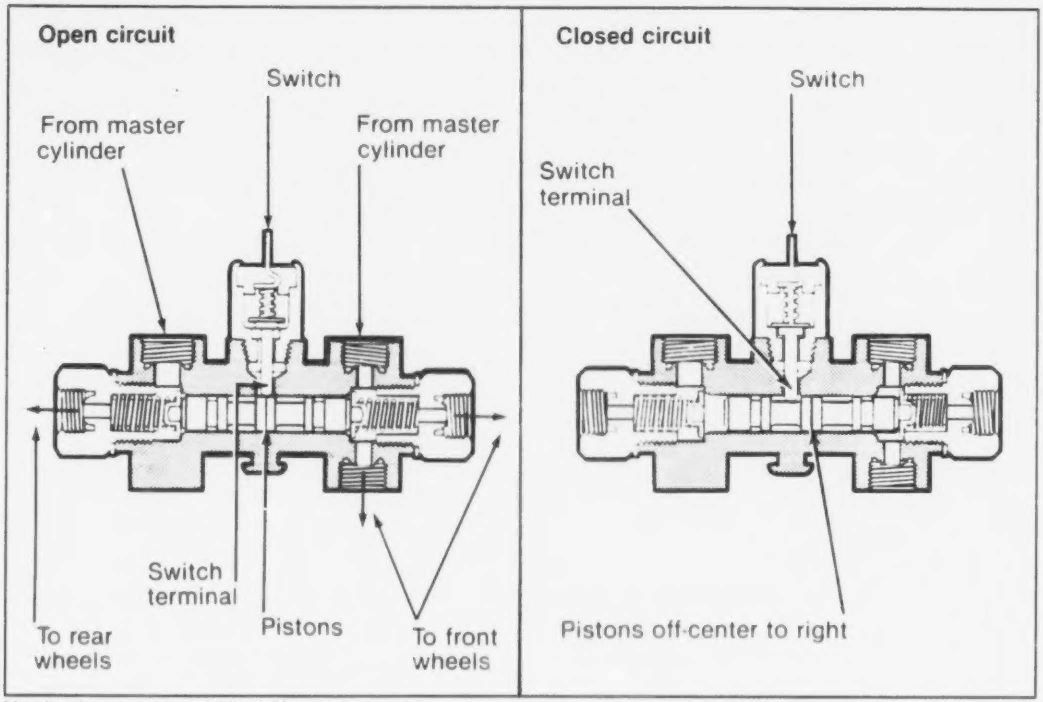
Closed circuit (warning light on) — Higher hydraulic pressure in operative side moves piston toward inoperative side of switch where piston shoulder pushes switch terminal upward, closing circuit and causing brake warning light to come on.

NOTE: With this type of switch, the warning light will remain on until the system is bled and the piston is again centered by equal hydraulic pressure in the bore of the switch.

May be photocopied for student use

- **Switch with centering spring and two pistons**

FIGURE 3


Open circuit
Switch
From master cylinder
From master cylinder
Switch terminal
Pistons
To rear wheels
To front wheels
Closed circuit
Switch
Switch terminal
Pistons off-center to right

Used with permission of Allied Aftermarket.

Open circuit (warning light off) — Piston shoulders hold switch terminal in UP position, keeping circuit open.

Closed circuit (warning light on) — Higher pressure in operative side moves both pistons toward inoperative side of switch, allowing switch terminal to drop downward and close the circuit, causing the brake warning light to come on.

NOTE: With this type of switch, the pistons will remain off center and the warning light will remain on until the switch terminal is removed from the switch body. This must be done *before* bleeding the hydraulic system on vehicles equipped with this type of switch; otherwise the switch terminal will be damaged.

May be photocopied for student use.

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 1

Recognize definitions of terms associated with the brake hydraulic system by choosing the correct definition from lists of three choices.

asbestosis — permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath

bleeding — process by which air and contaminants are removed from hydraulic system by draining part of the fluid or by operating system to work out these contaminants

brake — device used to slow, stop, or hold a vehicle by changing kinetic energy of motion into heat energy

KINETIC ENERGY

Kinetic energy is the term applied to energy in motion. When the braking system stops a vehicle, it does so by overcoming this energy in motion. The more energy that is in motion, the more power that is required to stop the vehicle. The amount of kinetic energy in a moving vehicle is the result of two things: how much the vehicle weighs and how fast the vehicle is going. If the weight or speed of a vehicle increases, the energy needed to stop the vehicle also increases. For example, it takes twice as much energy to stop a 4,000-pound car traveling at 30 mph as it does to stop a 2,000-pound car traveling at that same speed. If the speed of a vehicle is increased from 20 mph to 40 mph, the energy required to stop it quadruples—that is, increases by four times as much. Similarly, it takes eight times (2 × 4) as much energy to stop a 4,000-pound car traveling 40 mph as compared to what it takes to stop a 2,000-pound car traveling 20 mph.

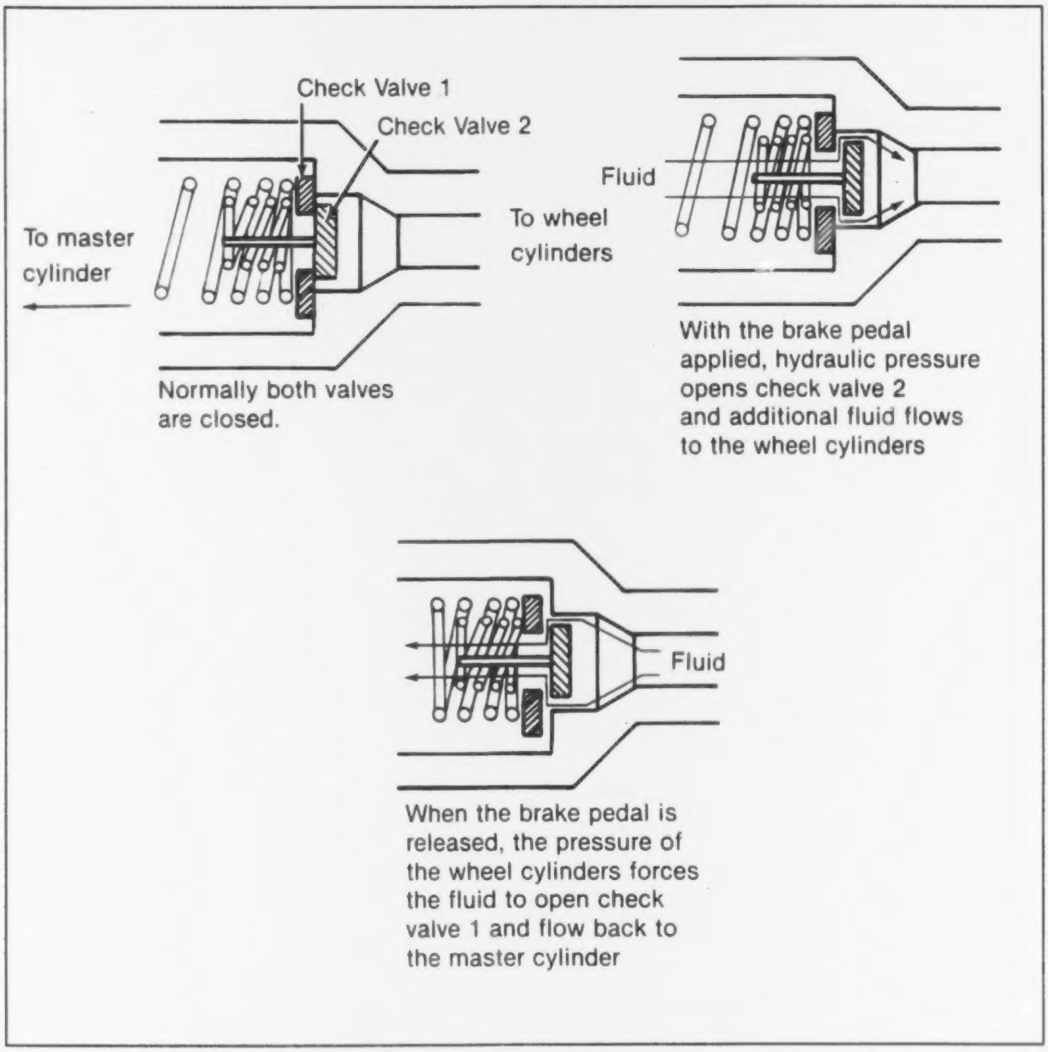
Not only does it take more energy to stop heavier and faster vehicles, but it also takes more time. This is because the kinetic energy of the vehicle must go somewhere. In an automotive braking system, this energy is changed to heat and can be felt in the brakes and wheel assembly of a car that has just stopped. However, even though a car traveling at a higher rate of speed requires more energy to stop it, the rate at which the brakes can convert that kinetic energy to heat remains the same. Thus, it takes longer for the vehicle going 40 mph to stop than the one going 30 mph because it takes longer for the brakes to dissipate the additional kinetic energy.

brake fluid — non-petroleum-based liquid used in hydraulic brake systems to transmit force through tubing known as brake lines

check valve — device that allows air or liquid to pass in one direction only

NOTE: The purpose of the fluid check valve—which is actually two separate valves in a single assembly—is to keep the hydraulic system under enough pressure to prevent air from entering it. See Figure 1.

FIGURE 1


Check Valve 1
Check Valve 2
To master cylinder
To wheel cylinders
Fluid
Fluid

Normally both valves are closed.

With the brake pedal applied, hydraulic pressure opens check valve 2 and additional fluid flows to the wheel cylinders

When the brake pedal is released, the pressure of the wheel cylinders forces the fluid to open check valve 1 and flow back to the master cylinder

dual master cylinder — component of the hydraulic system that converts driver force to hydraulic pressure; contains two pistons, each piston serving two wheel brakes

NOTE: Single-piston master cylinders were installed on domestic vehicles until 1966. The main purpose of the dual master cylinder is to provide a safety backup should one system fail.

flushing — process of removing all old fluid from hydraulic system and replacing it with new fluid

free play (brake) — clearance between master cylinder actuator rod and piston assembly

hydraulic power-assist unit — device that uses hydraulic pressure supplied by power steering pump or electrically driven pump to assist in applying brakes

lung cancer— cell-destroying disease presently responsible for largest number of deaths from exposure to asbestos

NOTE: Other cancers that appear to be caused by asbestos exposure include cancer of the stomach, large intestine, and voice box. The risks of getting cancer are increased significantly for smokers exposed to asbestos.

mesothelioma — fatal cancer of the lining of the chest or abdominal cavity caused by very low exposures to asbestos

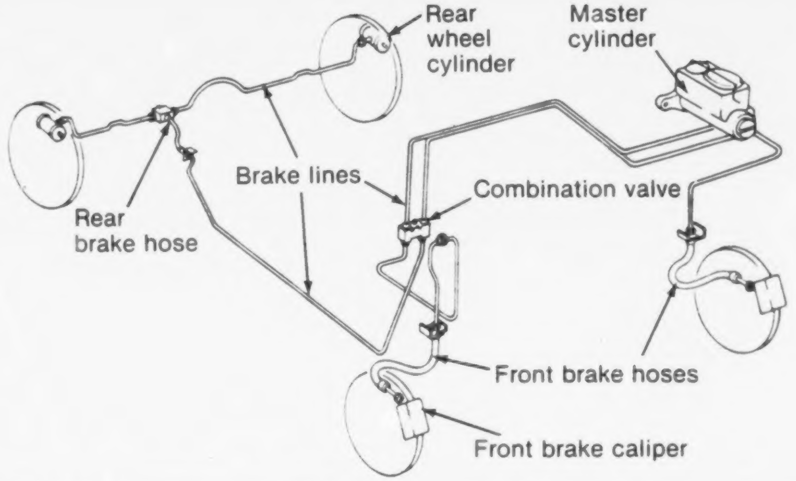
overhaul — to disassemble, recondition worn parts, replace defective parts, and reassemble a component or assembly

recondition — to machine or return a part to its original surface condition

vacuum power-assist unit — device that uses vacuum pressure supplied by intake manifold to assist in applying brakes

OBJECTIVE 2 **Label the basic components of a hydraulic brake system indicated on an illustration.**

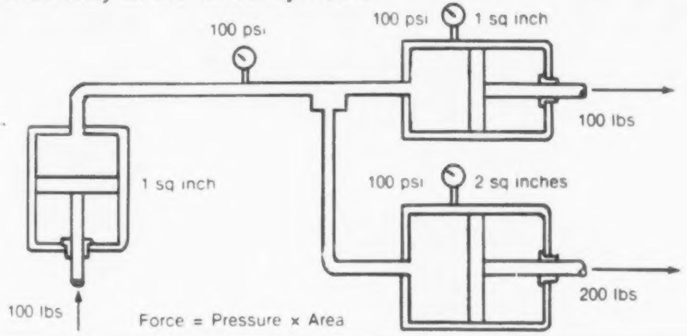
FIGURE 2


Rear wheel cylinder
Master cylinder
Brake lines
Combination valve
Rear brake hose
Front brake hoses
Front brake caliper

Courtesy Chrysler Corp.

OVERCOMING FORCE

Tremendous forces are involved when braking a vehicle because a vehicle must be brought to a stop in a much shorter time than is required to bring it up to speed. For instance, a vehicle with a 100-horsepower engine requires about 60 seconds to accelerate to 60 miles per hour. However, the same vehicle is expected to be able to stop from 60 miles per hour in not more than 6 seconds. In other words, the brakes must do the same work as the engine, but in one-tenth the time. In this case, this means that they must develop 1000 horsepower to stop the vehicle. Hydraulic brakes provide the force needed to brake a vehicle. The drawing below shows how force applied to the brake pedal is multiplied hydraulically at the wheel cylinders.

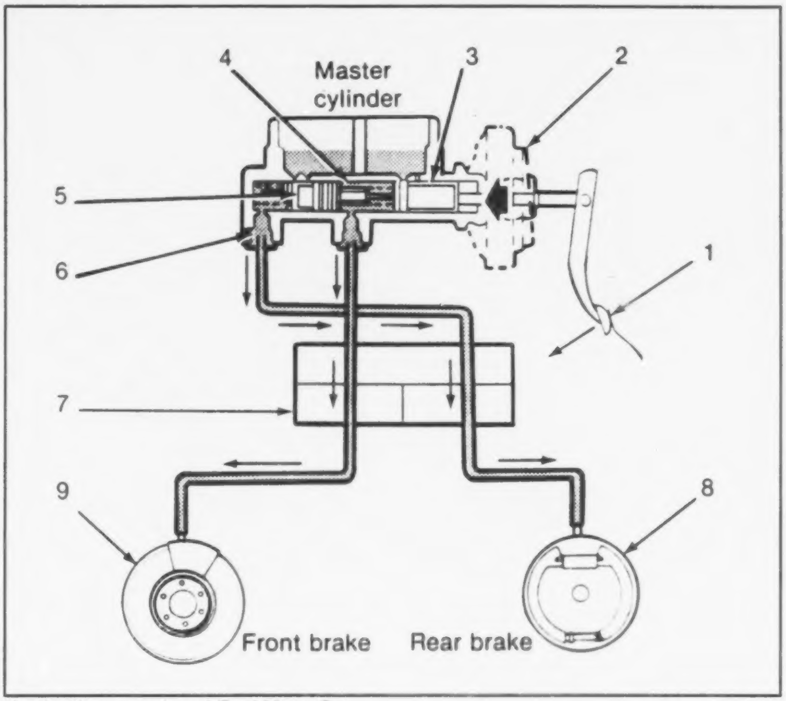

100 psi
100 psi
1 sq inch
100 lbs
1 sq inch
100 psi
2 sq inches
200 lbs
100 lbs
Force = Pressure × Area

OBJECTIVE 3

List the steps of hydraulic brake operation in order.

EXAMPLE:

FIGURE 3



Used with permission of Ford Motor Co.

1. Brake pedal is depressed.
2. Booster (if used) increases force into master cylinder.
3. Pushrod forces primary piston forward.
4. Fluid in primary cylinder is pressurized to apply front brakes.
5. Pressure in primary cylinder pushes secondary piston forward.
6. Secondary cylinder is pressurized to apply rear brakes.
7. Brake combination valve is used to
    - delay (meter) front brake application
    - proportion rear pressure to front pressure on some models
    - trigger warning system

8. Pistons in wheel cylinder push brake shoes against drum in drum-type brakes used on rear wheels.

9. Piston(s) in caliper forces brake pad against rotor in disc-type brakes used on front wheels.

OBJECTIVE 4 **Define the characteristics of good brake fluid.**

Viscosity — Should be free-flowing at all temperatures

Boiling point — Should have high boiling point so that it remains in liquid state at highest operating temperatures encountered

Corrosion — Should be noncorrosive so that it does not attack rubber or metal parts, and should act as an antirust agent

Water tolerance — Should be able to absorb and retain moisture that collects in system

Lubricating ability — Should lubricate pistons and cups to reduce wear and internal friction

Freezing point — Should have low freezing point so that it remains fluid and flows at low ambient and operating temperatures

TYPES OF BRAKE FLUID

Federal law requires that brake fluid meet certain standards and specifications before it is sold. The federal government has set specifications for three types of brake fluid for automotive use: DOT 3, DOT 4, and DOT 5. Each type must have a specified color. DOT 3 and DOT 4 are amber to clear in color, while DOT 5 is purple. The main differences between DOT 3 and DOT 4 are that DOT 4 has a higher wet boiling point and absorbs moisture more slowly than does DOT 3 fluid. DOT 5 fluid is silicone-based and has a higher boiling point than either of the other two types. DOT 3 and DOT 4 may be mixed with each other, but DOT 5 should **never** be mixed with either of them. Before using DOT 5, check vehicle manufacturer's specifications—some manufacturers advise against the use of DOT 5 brake fluid.

OBJECTIVE 5 **Recognize guidelines for handling and storing brake fluid.**

- Change brake fluid at each major brake repair, taking care not to spill fluid on any chrome or painted surface as it will damage these finishes.
- Always keep fluid clean; do not allow any foreign material or petroleum product (gasoline, kerosene, oil, grease) to get into the fluid
- Never use containers contaminated with grease, oil, dirt, rust, etc.
- Always clean off top of fluid reservoir before refilling it in order to avoid contamination of brake fluid.
- Use smallest possible can of brake fluid to fill master cylinder; use two small cans rather than half a large can.
- Tightly cap fluid container after use.
- Keep master cylinder tightly covered, and reinstall cover immediately after filling master cylinder with new fluid.
- Keep fluid reservoir in pressure brake bleeder tightly closed except when refilling.
- Store brake fluid away from heat or flame, as it is highly flammable.

MORE ABOUT BRAKE FLUIDS

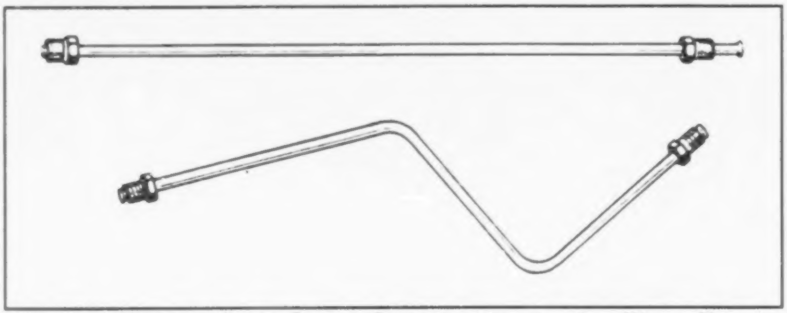
Brake fluids (except silicone) absorb moisture when exposed to air. This greatly reduces their boiling point. High-temperature fluids (specified for heavy-duty and disc-brake use) lose their boiling points more quickly than regular fluids. Absorption of even 3 percent moisture brings down the boiling point of high-temperature fluids by about 50 percent. This can happen if a master cylinder cap is left off overnight or if a can is left partially filled for even a day or two. The effect of moisture contamination and a reduced boiling point is vapor lock, a condition that occurs when brake heat boils the fluid into vapor so that the pedal stroke is used up to compress the gas. With enough vapor accumulation, the master cylinder can run out of stroke before the brakes are applied. Often this condition disappears before being checked, since the vapor returns to fluid when it is cooled. To be safe, always replace the fluid when you suspect moisture contamination.

OBJECTIVE 6 **Complete statements describing hydraulic lines and fittings.**

tubing — Hollow brake line of bendable steel coated to resist rust and corrosion and double flared at both ends to accept male fittings (Figure 4)

EXAMPLE:

FIGURE 4

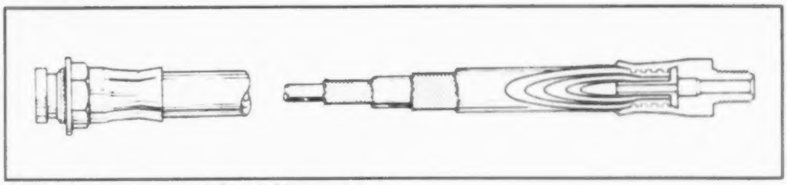


Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

hose — Hollow brake line of alternating layers of flexible rubber and fabric with threaded metal fittings at both ends (Figure 5)

EXAMPLE:

FIGURE 5

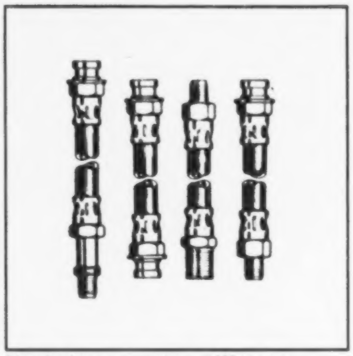


Used with permission of Allied Aftermarket.

hose end fittings — Threaded metal fittings designed to grip both inside and outside of hose; generally one end accepts a male fitting and the other accepts a female fitting (Figure 6)

EXAMPLE:

FIGURE 6

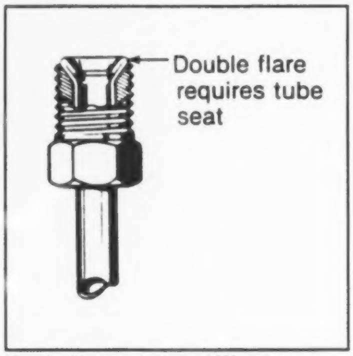


Used with permission of Wagner Division, Cooper Industries, Inc., from Wagner Manual AU-1600/Feb., 1984.

double flare fitting — Double lapped and flared steel tubing that is secured with a line or tube nut and requires a tube seat (Figure 7)

EXAMPLE:

FIGURE 7



Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

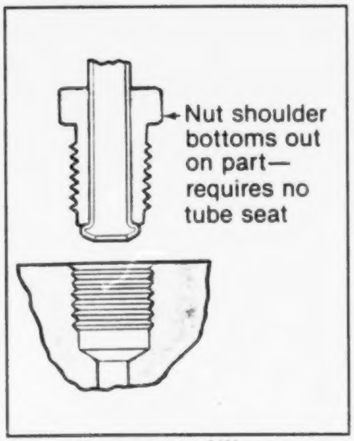
International Standards Organization (ISO) flare fitting

Flare design that requires no tube seats and cannot be overtightened because shoulder of line or tube nut bottoms out in body of part, creating uniform pressure on flare (Figure 8)

NOTE: The ISO flare is a fairly new design and is rapidly gaining acceptance. It has a number of advantages over the standard double flare: (1) Tube seats are no longer needed, (2) when tightened the shoulder of the nut bottoms out in the body of the part, creating a uniform pressure on the flare, and (3) the design is not subject to overtightening. The brakes specialist body of the part, creating a uniform pressure on the flare, and (3) the design is not subject to overtightening. The brakes specialist merely tightens the nut firmly on the seat, and the correct sealing pressure occurs automatically.

EXAMPLE:

FIGURE 8



Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

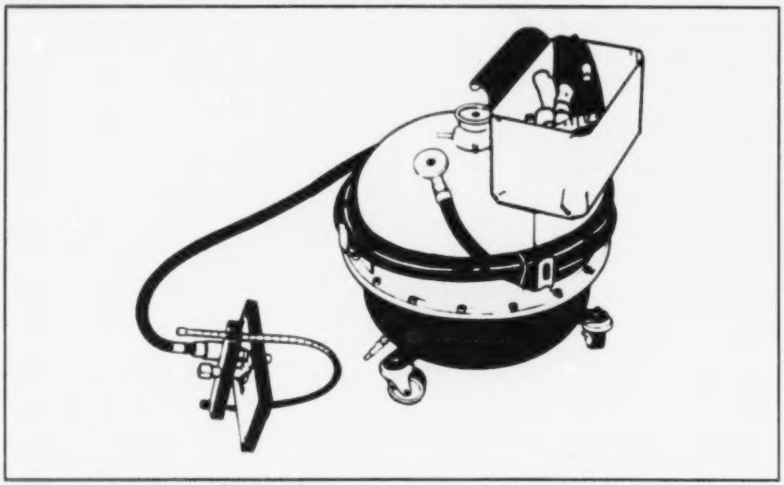
OBJECTIVE 7

Determine the correct specialty tool to use to service the hydraulic system and wheel bearings.

brake pressure bleeder — Removes air and contaminants from the hydraulic system by supplying pressurized fluid to the master cylinder reservoir (Figure 9)

EXAMPLE:

FIGURE 9

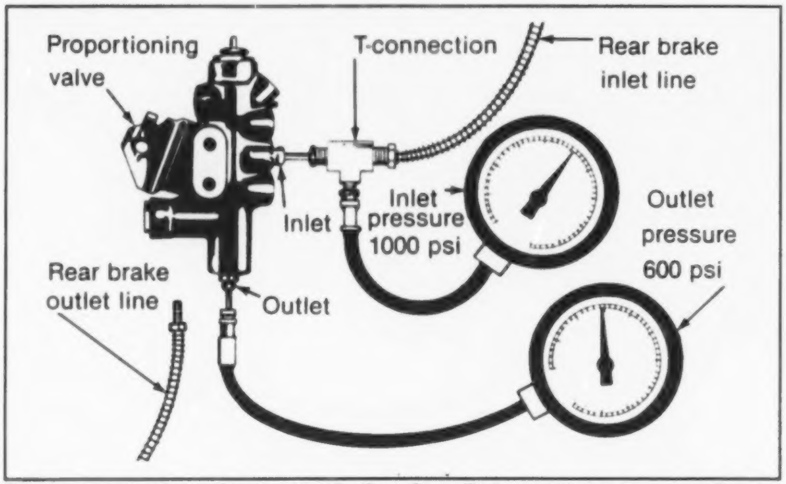


Used with permission of Chrysler Corp.

pressure gauge — Used to test operation of a proportioning valve (Figure 10)

EXAMPLE:

FIGURE 10

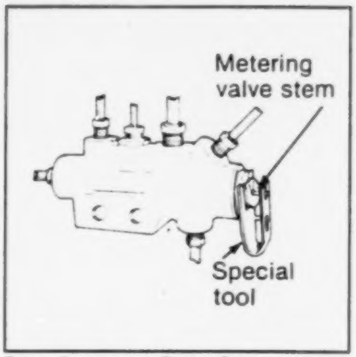

Proportioning valve
T-connection
Rear brake inlet line
Inlet
Inlet pressure 1000 psi
Outlet pressure 600 psi
Rear brake outlet line
Outlet

From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic system Service* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

metering valve tool — Holds the metering valve open when pressure bleeding the front brakes (Figure 11)

EXAMPLE:

FIGURE 11

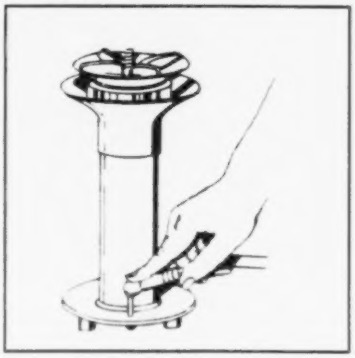


From *Automotive Brake Service, Unit 2: Front Disc Brake Service* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

wheel bearing packer — Used to force bearing grease into all parts of cone-and-roller bearing assembly (Figure 12)

EXAMPLE:

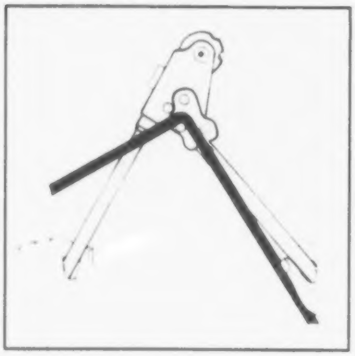
FIGURE 12



lever-type tubing bender —
Shapes flared or unflared metal tubing without kinking it (Figure 13)

EXAMPLE:

FIGURE 13

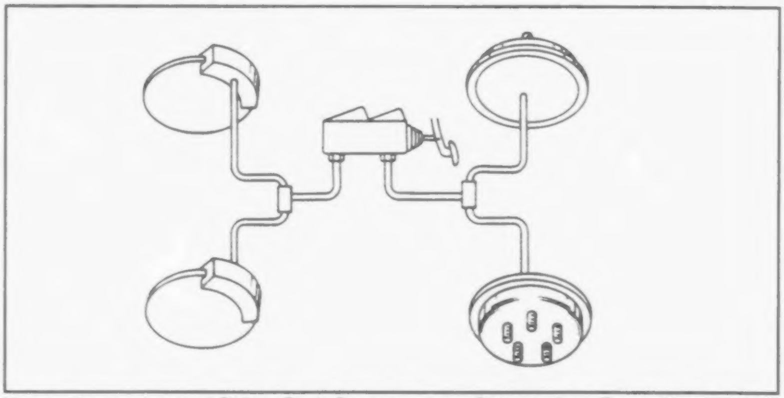


OBJECTIVE 8

Complete drawings of the hydraulic circuits for dual braking system designs.

- **Front-to-rear split system** (Figure 14)

FIGURE 14

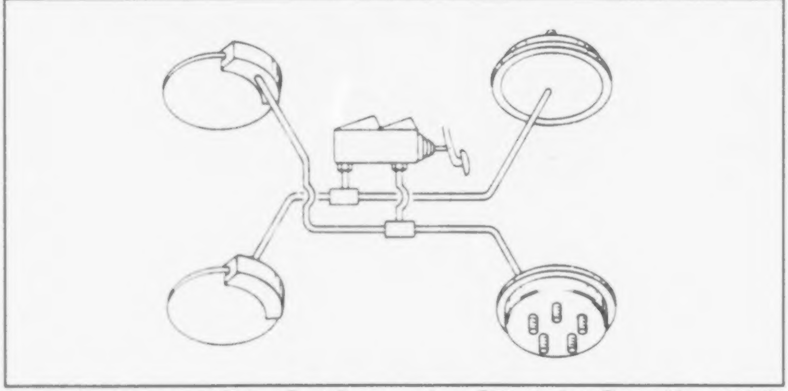


Used with permission of Chilton Book Company, from *Chilton's Auto Repair Manual 1985.*

NOTE: The ***front-to-rear split*** design, in which both front wheels are on one hydraulic circuit and both rear wheels are on another, is the original and most common dual system design on domestic vehicles. If the rear system fails, the front system stops the vehicle.

- **Diagonally split system** (Figure 15)

FIGURE 15



Used with permission of Chilton Book Company, from *Chilton's Auto Repair Manual 1985*

> **NOTE:** In a ***diagonally split*** system, the right front and left rear wheels are on one hydraulic circuit and the left front and right rear wheels are on another. Foreign cars were the first to use this design because it is especially well suited to vehicles with front engines and front-wheel drive. These vehicles do not have enough rear axle weight to provide adequate stopping if failure occurs in the front brake system of front-to-rear split brakes. The diagonally split design, however, provides equal stopping power in the event of failure in either half of the system.

OBJECTIVE 9

Evaluate asbestos safety practices.

- Use the most up-to-date, EPA-approved enclosure-type brake cleaner equipped with a HEPA-type vacuum cleaner filter.

- Follow enclosure-equipment installation and use procedures to the letter, making sure that equipment is properly in place before any service begins.

- Always follow manufacturer's instructions for changing filter or collection bag.

- Never use compressed air to clean the brake assembly, your clothing, or the work area.

- Do not sweep the work area with a broom or garden hose; use a vacuum cleaner equipped with a HEPA filter.

- Whenever possible, use pre-ground, installation-ready brake linings.

- Do not eat, drink, or smoke in any area where brake work is done.

- Wash your hands and face before eating, and wash all exposed skin and change clothes before going home.

  NOTE: Your employer should see to the laundering of your work clothes. If possible, work clothes should be laundered at special facilities equipped to wash clothing contaminated with asbestos.

- Wear an air-purifying respirator with HEPA cartridges only as secondary protection against accidental disturbance of asbestos dust, and not as a substitute for the use of enclosure-type equipment.

  NOTE: Air-purifying respirators with HEPA cartridges may be appropriate for *secondary* protection during floor cleaning, filter or collection bag changing, and waste disposal. It should be noted that while NIOSH and EPA do not recommend the use of air-purifying respirators with HEPA cartridges in asbestos environments, various existing regulations currently allow their use.

- Even though asbestos friction materials are being phased out, assume for the sake of caution that *all* such materials contain asbestos, and follow appropriate safety guidelines.

- Educate yourself to the dangers of asbestos exposure and take responsibility for your own safety and that of others: Do not take a job in a shop that is careless in its asbestos safety procedures, and refuse to work or train in an unsafe environment; your life could depend on it.

ASBESTOS

Friction materials such as brake linings and clutch facings often contain asbestos. Millions of asbestos fibers can be released during brake and clutch servicing. Grinding and beveling friction products can cause even higher exposures. Like germs, asbestos fibers are small enough to be invisible and they can remain and accumulate in the lungs. When you see a cloud of dust during brake work, you are seeing clumps containing thousands of fibers.

Asbestos released into the air lingers around a garage long after a brake job is done and can be breathed by everyone inside the garage, including the customers. While lowering exposure lowers risk, *there is no known level of exposure to asbestos below which health effects do not occur*. The EPA has proposed phasing out the use of asbestos products. In situations where asbestos exposures cannot be eliminated entirely—the auto shop, for instance—exposures must be reduced to the lowest possible level.

Asbestos can be carried on work clothing, contaminating the family car and home. This contamination can cause asbestos disease among family members. An ordinary house or shop vacuum cleaner cannot collect these asbestos fibers because the filter is not fine enough to trap them. In fact, an ordinary vacuum cleaner (one that is not equipped with a high-efficiency particulate air, HEPA, filter) is likely to stir up asbestos fibers and scatter them into the air.

Asbestos can also get on a mechanic's hands and be swallowed when the automotive specialist smokes a cigarette or eats. This is a particularly difficult problem for specialists as they often get grease on their hands, and asbestos fibers can stick to the grease.

Until the use of asbestos products is phased out, the best way of limiting health damage is to use proper controls. Effective asbestos containment prevents problems associated with housekeeping and with stirring up settled dust. The best approach is to follow all asbestos safety guidelines designed to contain brake dust and to prevent its release into the shop or garage.

From Environmental Protection Agency Office of Pesticides and Toxic Substances. Asbestos Action Program, *Guidance for Preventing Asbestos Disease Among Auto Mechanics*, June 1986.

OBJECTIVE 10

Match terms associated with wheel bearings to their definitions.

bearing — Part that transmits a load to a support and thus absorbs most of the friction and wear of the moving part

bearing cone assembly — Part of roller bearing that contains inner race, roller cage, and rollers; installed on spindle with a push fit

bearing race (cup) — Part of bearing that contains outer race; installed in hub with a press fit

end play (bearing) — Amount of axial movement in hub due to clearance in bearings

packing — Process of cleaning old grease from bearings and then forcing new wheel bearing grease into openings between races and ball or roller cages; may be done manually or mechanically

preload — To adjust bearings so that they will work under mild pressure

press fit — Installation of a bearing cup with a tight or interference fit requiring more than hand pressure to install

push fit — Installation of a bearing cone assembly with a light fit that can be installed with hand pressure

race — Surface or path on which bearing balls or rollers move

viscosity — Thickness of a fluid; resistance to flow

WHEEL BEARINGS

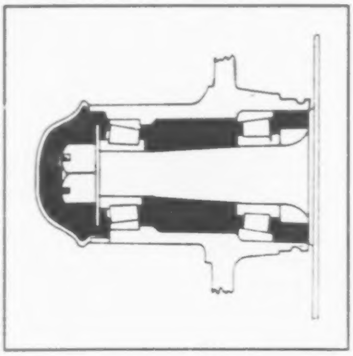
Wheel bearings come in pairs of inner and outer bearings. They allow the wheels of a vehicle to turn freely over thousands of miles by cushioning the contact between the wheel and its spindle. The grease used to lubricate the bearings tends to pick up dust, dirt, and little particles of metal, although the bearings are to some degree protected by the hub and brake drum or rotor. It is important to check the bearings at least as often as the brakes are checked to be sure that the grease has not become fouled. If it has, the dirt particles will act abrasively to wear away the very connection other grease was designed to protect, and the result will be a noisy, grinding ride. A good time to have wheel bearings repacked is when a front-end alignment or brake job is performed, because the wheels will be off anyway and this will eliminate duplicating labor. Front-wheel bearings on a driving hub and wheel bearing assembly are normally not serviced unless specified or when major repairs are needed. Service of rear-wheel bearings on front-wheel-drive vehicles is basically the same as that for front bearings.

OBJECTIVE 11 **Identify types of wheel bearings shown in illustrations.**

- **Tapered roller bearings** (Figure 16)

  NOTE: The *tapered roller bearing* is the bearing design most commonly used on today's automobiles. Each front-wheel hub normally uses a pair of tapered roller bearings.

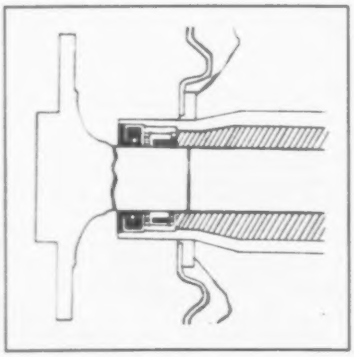
FIGURE 16



- **Straight roller bearings** (Figure 17)

  NOTE: *Straight roller bearings* are used on rear-wheel assemblies of some medium-to-heavier-weight automobiles.

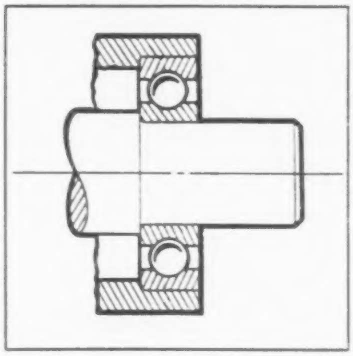
FIGURE 17



- **Ball bearings** (Figure 18)

  NOTE: *Ball bearings* are used on the rear wheels of some light vehicles.

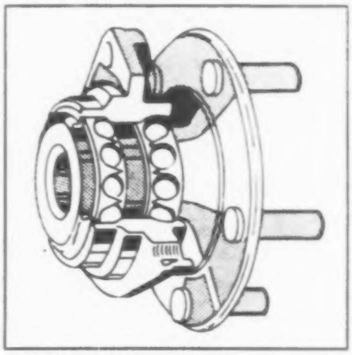
FIGURE 18



- **Integrated ball bearings** (sealed bearings) (Figure 19)

  NOTE: *Integrated ball bearings* are found primarily on front-wheel drive vehicles. The inner bearing races are combined with a conventional spindle. The outer bearing races are part of the hub/flange.

FIGURE 19



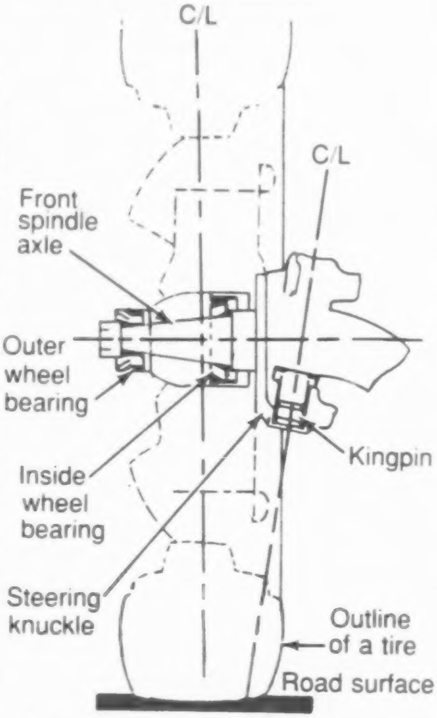
OBJECTIVE 12

List the purposes of wheel bearings.

- To reduce friction between revolving wheel hub and spindle
- To spread vehicle loads over a larger surface area

  NOTE: The wheel bearings transmit the vehicle's radial (vertical) load and thrust (side-to-side) load as the wheels revolve.

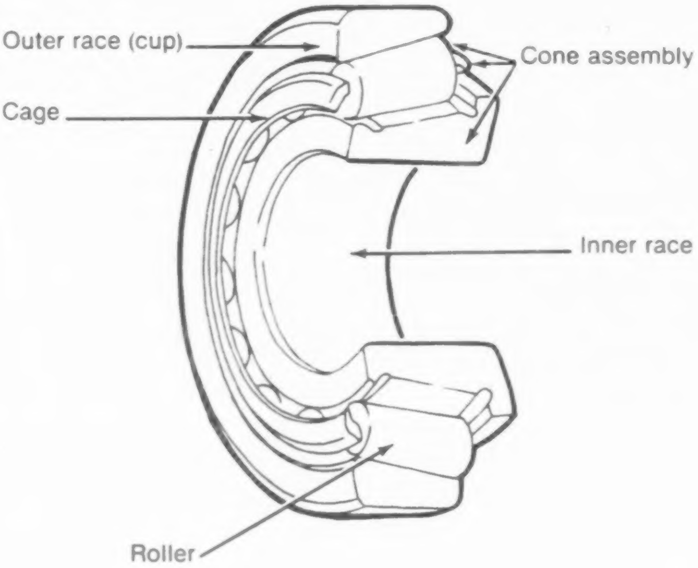
WHEEL BEARINGS AND LOAD LINES


C/L
C/L
Front spindle axle
Outer wheel bearing
Inside wheel bearing
Steering knuckle
Kingpin
Outline of a tire
Road surface

Both the outer and inner wheel bearings support the weight of the vehicle. As shown in the figure at the right, the center load line of the wheel is almost in line with the inner wheel bearing. This design causes most of the weight to be carried on the largest (inner) wheel bearing, which is on the thickest portion of the spindle and nearest the pivot point of the spindle. This weight distribution reduces the chance of breaking the spindle. Since the wheel center load line intersects the road surface at nearly the same point as the steering axis centerline, the tire turns on nearly a single point of the road surface. This reduces the effort required to turn the wheel to a minimum.

OBJECTIVE 13 **Label the parts of a tapered roller wheel bearing indicated on an illustration.**

FIGURE 20



WHEEL BEARING NOISES

On rear-wheel drive vehicles, loose or rough front wheel bearings produce a noise that may be confused with rear axle noises. The difference is that front wheel bearing noise does not change when the vehicle is coasting or accelerating. A light application of the brake while holding the vehicle's speed constant often causes bearing noise to diminish because this action reduces some of the weight supported by the bearings. In the shop, front wheel bearings may be checked easily for noise by raising the suspected wheel and then spinning it. If the vehicle is equipped with disc brakes, the brake pads must be disengaged from the rotor before performing this check. During a road test, the bearings may be checked by moving the steering wheel to the right and left while listening for noise.

OBJECTIVE 14

Recognize properties of wheel bearing grease.

- Is water-resistant
- Is heat-resistant

  NOTE: Wheel bearing grease will not lose its viscosity as the temperature rises.

- Is stable at high temperatures

  NOTE: Wheel bearing grease will not separate at high temperatures.

- Is noncorrosive
- Adheres to friction surfaces

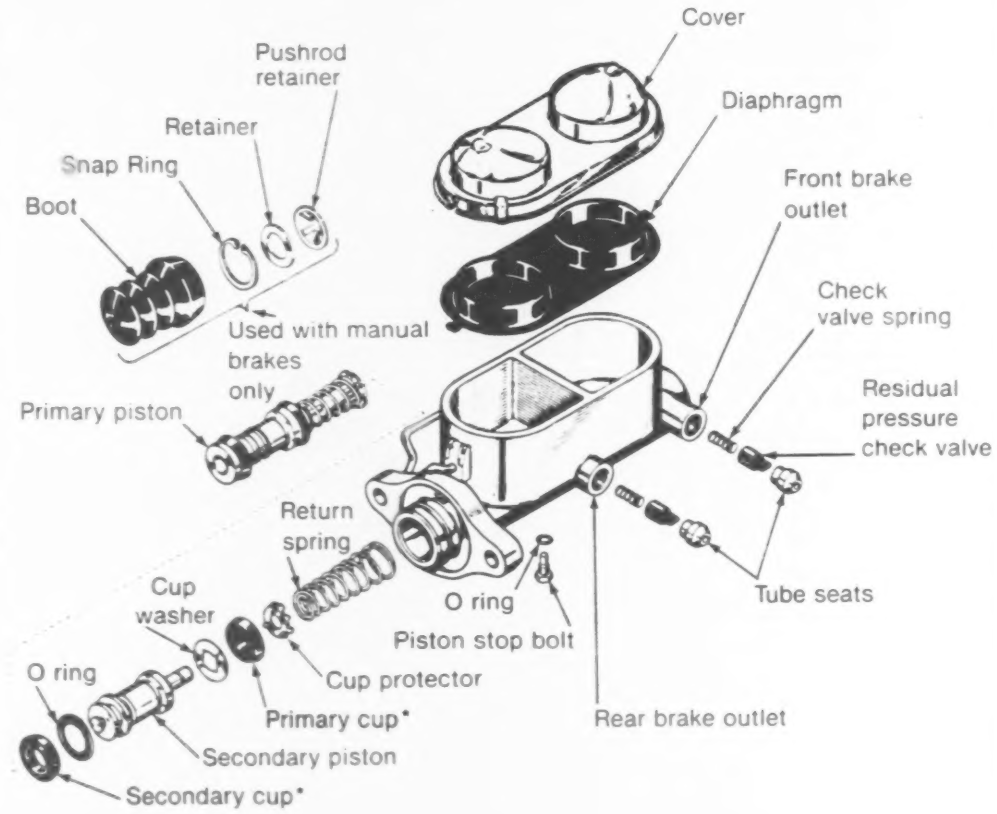
  NOTE: Wheel bearing grease will adhere to metal and will not form acids under adverse conditions.

WHEEL BEARING LUBRICATION

While some rear wheel bearings are automatically lubricated by oil creeping along the axle shaft from the differential, others are sealed and require separate lubrication. Rear axles with seals on the outboard of the bearing usually indicate that the bearing is lubricated by differential oil. Seals in the housing on the inside of the bearing (toward the differential side) must be prelubricated and sealed or repacked at certain intervals. The vehicle manufacturer supplies lubrication charts that should be followed for both type and frequency of lubrication. Front wheel bearings call for the use of a special wheel bearing grease of short fiber and with a high melting point. The high melting point is critical because the brake drums surrounding the wheel bearings sometimes get as hot as 700 degrees Fahrenheit. Not all of this heat is applied to the wheel bearings, but a considerable amount is absorbed by the hubs. If the grease melts, it may get by the oil seal and ruin the brake linings. In this case, the bearings will also be damaged due to loss of lubrication.

OBJECTIVE 15 **Label the parts of a dual master cylinder indicated on an illustration.**

FIGURE 21


Cover
Pushrod retainer
Diaphragm
Retainer
Snap Ring
Front brake outlet
Boot
Check valve spring
Used with manual brakes only
Residual pressure check valve
Primary piston
Return spring
Cup washer
Tube seats
O ring
O ring
Piston stop bolt
Cup protector
Primary cup*
Rear brake outlet
Secondary piston
Secondary cup*

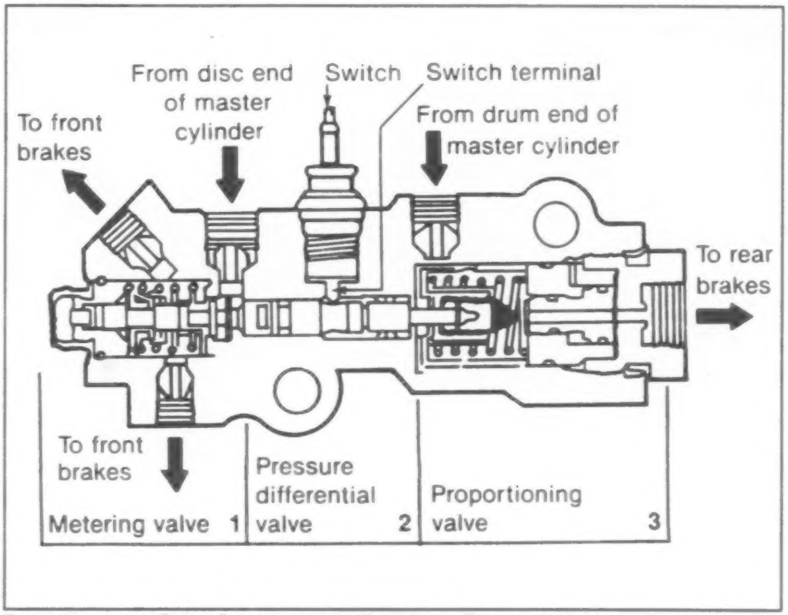
*Note position of secondary cup in relation to primary cup. They face opposite directions.

Adapted with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

OBJECTIVE 16

Match the names and functions of combination valve components to an illustration.

FIGURE 22


From disc end of master cylinder
Switch
Switch terminal
To front brakes
From drum end of master cylinder
To rear brakes
To front brakes
Metering valve 1
Pressure differential valve 2
Proportioning valve 3

From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

1. **Metering valve** — Delays hydraulic pressure to front brakes until after rear brakes are applied

2. **Pressure differential valve** — Turns on a warning light if the pressure drops in one part of the system

3. **Proportioning valve** — Reduces pressure to rear wheels during hard braking

FUNCTIONS OF A COMBINATION VALVE

Proper operation of combination valve components is very important. For instance, the metering valve is tied into the brake lines leading to the front brakes. If the front brakes apply before the rear brakes, directional control becomes difficult. In an emergency, the vehicle could spin. The metering valve assures that the front wheels will apply just *after* the rear brakes.

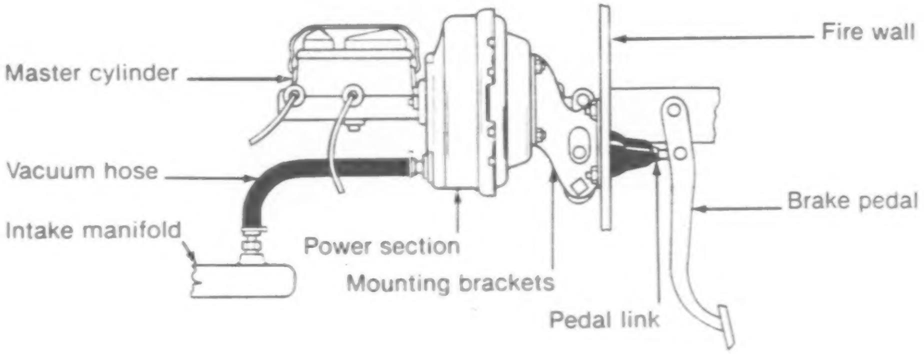
In addition, during hard braking, when the driver makes a panic stop, the vehicle dips and the rear end comes up. Because more weight is transferred to the front of the vehicle, the rear wheels are more likely to lock. By reducing pressure to the rear brakes, the proportioning valve prevents this type of lockup.

Not only does the combination valve perform both of these functions, but it also has a brake warning light switch that actuates a red light on the instrument panel. This light alerts the driver to the failure of one or the other of these brake systems.

OBJECTIVE 17 **Label types of power-assist units shown in illustrations.**

- **Vacuum power-assist unit** (Figure 23)

FIGURE 23

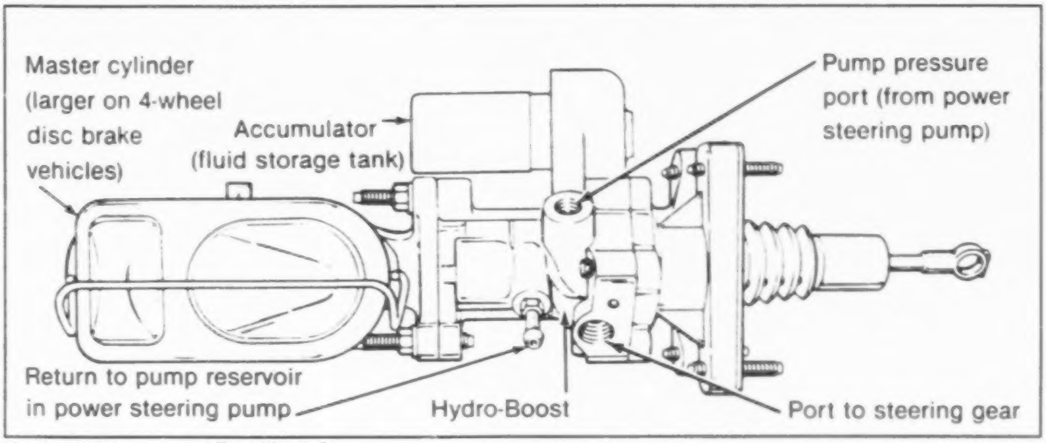


Used with permission of Allied Aftermarket.

NOTE: All power brake boosters, regardless of design, function to reduce braking effort and to increase force to the brake system. The ***vacuum power-assist unit*** is the type of power booster most commonly found on today's vehicles.

- **Hydraulic power-assist unit with mechanical pump** (Figure 24)

FIGURE 24

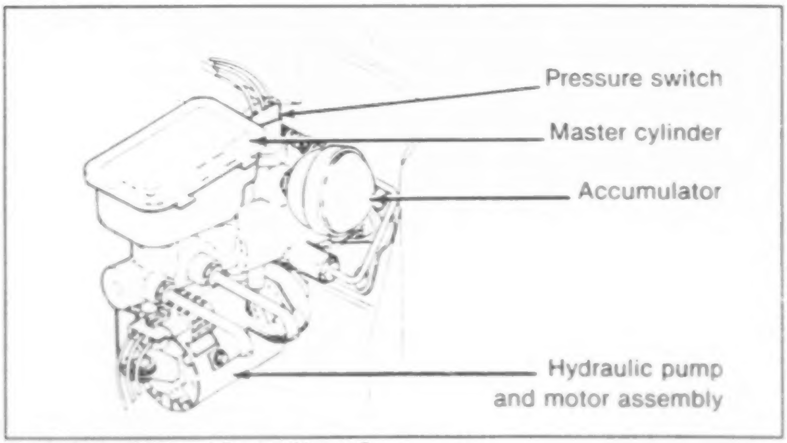

Master cylinder (larger on 4-wheel disc brake vehicles)
Accumulator (fluid storage tank)
Pump pressure port (from power steering pump)
Return to pump reservoir in power steering pump
Hydro-Boost
Port to steering gear

Used with permission of Ford Motor Co.

NOTE: General Motors makes two designs of ***hydraulic power-assist units with mechanical pumps*** powered by hydraulic pressure from the power steering pump: Hydro-Boost I and Hydro-Boost II. Hydro-Boost I units have an accumulator separate from the booster. Hydro-Boost II designs incorporate the accumulator into the power piston. Figure 24 is an external view of a unit with separate accumulator.

- **Hydraulic power-assist unit with electrical pump** (Figure 25)

FIGURE 25

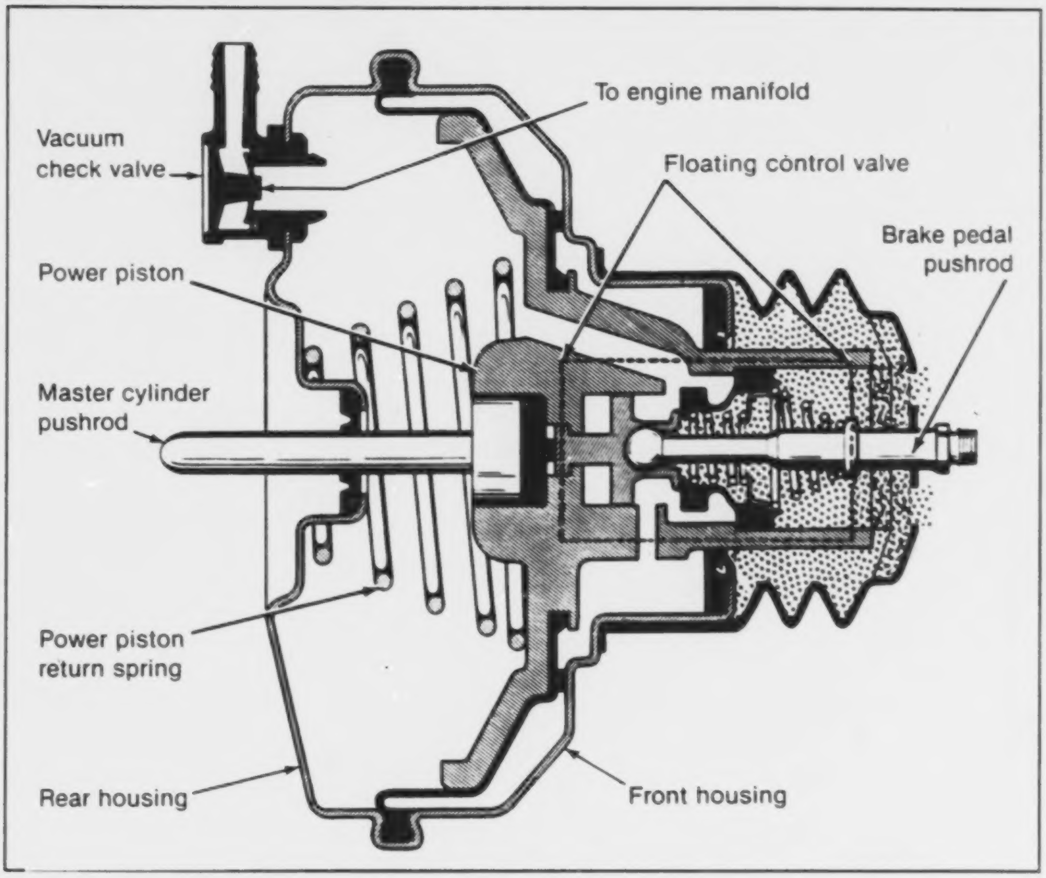

Pressure switch
Master cylinder
Accumulator
Hydraulic pump and motor assembly

Used with permission of General Motors Corp.

NOTE: The ***hydraulic power-assist unit with an electrical pump*** is a fairly new type of power-assist unit which uses an electric motor rather than the power steering pump to drive its hydraulic pump. This design is presently found on some General Motors and Ford vehicles.

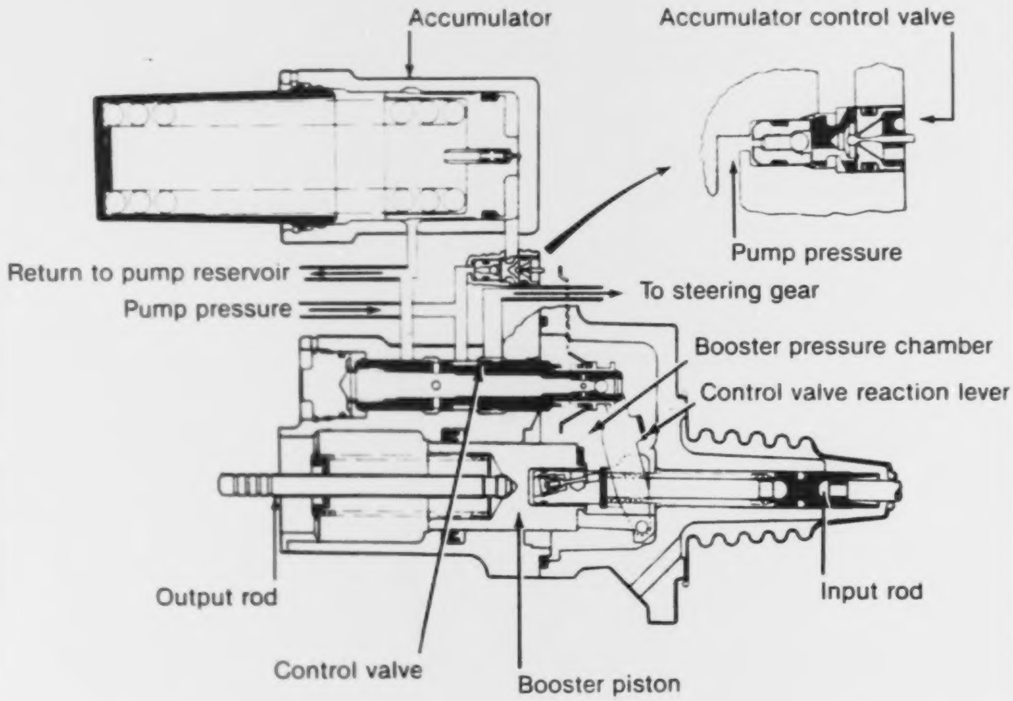
OBJECTIVE 18 **Label the parts of a vacuum power-assist unit indicated on an illustration.**

FIGURE 26


To engine manifold
Vacuum check valve
Floating control valve
Brake pedal pushrod
Power piston
Master cylinder pushrod
Power piston return spring
Rear housing
Front housing

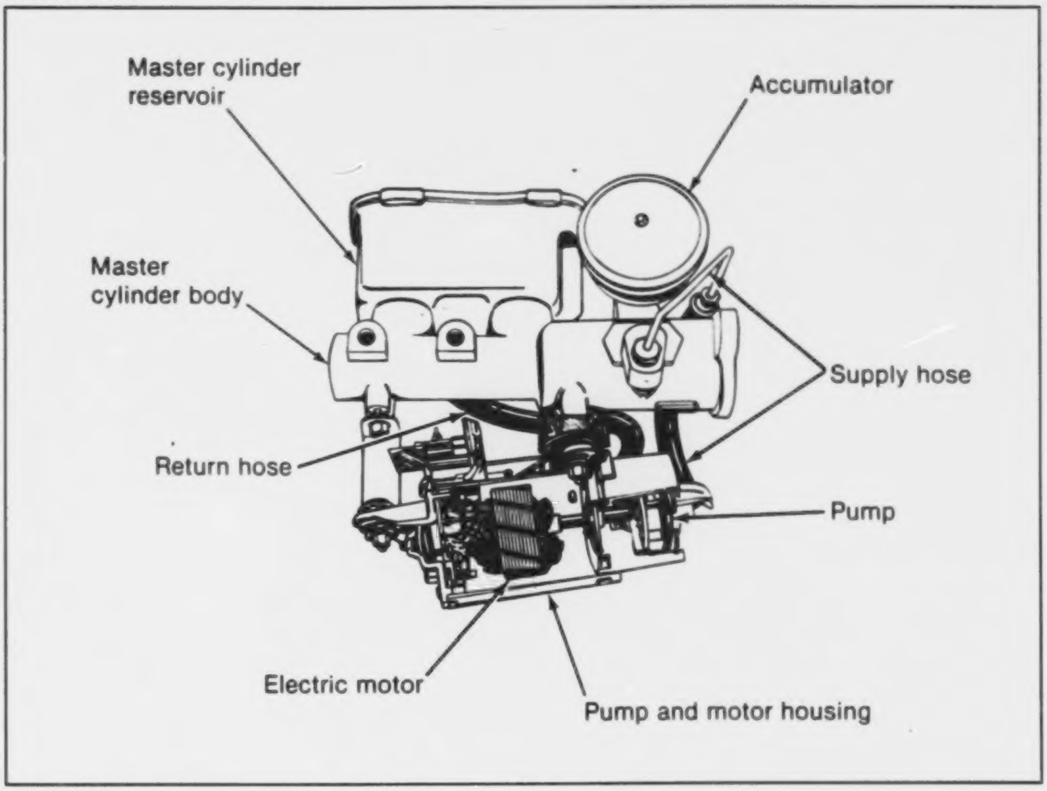
OBJECTIVE 19 **Label the major parts of a hydraulic power-assist unit (mechanical pump) indicated on an illustration.**

FIGURE 27


Accumulator
Accumulator control valve
Pump pressure
Return to pump reservoir
Pump pressure
To steering gear
Booster pressure chamber
Control valve reaction lever
Output rod
Input rod
Control valve
Booster piston

OBJECTIVE 20 **Label the major parts of a hydraulic power-assist unit (electrical pump) indicated on an illustration.**

FIGURE 28


Master cylinder reservoir
Accumulator
Master cylinder body
Supply hose
Return hose
Pump
Electric motor
Pump and motor housing

DIAGNOSTIC CHART FOR BASIC HYDRAULIC SYSTEM PROBLEMS

NOTE: This chart covers conditions caused by brake system hydraulic problems. However, some of these conditions may result from other malfunctions, such as brake mechanical problems, wheel bearing defects, or problems in the suspension or steering systems. This chart is intended to help you diagnose suspected brake hydraulic system problems. Other procedures may be required if the problem is elsewhere.

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Low pedal, excessive pedal travel	Leak in hydraulic system	Check master cylinder, wheel cylinders, calipers, tubes, and hoses for leakage; repair or replace faulty parts
	Air in hydraulic system	Bleed hydraulic system
	Poor-quality brake fluid (low boiling point)	Flush hydraulic system and fill with approved brake fluid
	Low brake fluid in master cylinder reservoir	Fill master cylinder and bleed hydraulic system
	Weak brake hoses that expand under pressure	Replace defective hoses
	Improperly adjusted manual master cylinder pushrod	Adjust pushrod (if vehicle has adjustable pushrod)
	Residual pressure check valves not holding pressure in lines	Repair or replace master cylinder

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Springy or spongy pedal	Poor-quality brake fluid (low boiling point)	Flush hydraulic system and fill with approved brake fluid
	Weak brake hoses that expand under pressure	Replace defective hoses
	Air in hydraulic system	Bleed hydraulic system
Hard pedal (excessive pedal pressure needed to stop vehicle)	Clogged master cylinder tubes or hoses	Replace tubes or hoses as necessary
	Frozen master cylinder piston(s)	Repair or replace master cylinder
Grabby brakes, sensitive brakes, braking too severe	Rough or corroded master cylinder bore	Recondition bore or replace master cylinder
Car pulls to one side	Sticking wheel cylinder piston	Repair or replace wheel cylinder
	Sticking caliper piston	Repair or replace caliper
Decreasing brake pedal travel	Sticking wheel cylinder piston	Repair or replace wheel cylinder
	Plugged master cylinder compensating ports	Repair or replace master cylinder
	Swollen master cylinder cups	Repair or replace master cylinder, flush hydraulic system, and fill with approved brake fluid
All brakes drag, car does not roll freely (but brake adjustment is correct)	Soft or swollen rubber parts caused by incorrect or contaminated brake fluid	Replace all rubber parts; flush hydraulic system and fill with approved brake fluid
	Plugged master cylinder compensating ports	Repair or replace master cylinder

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
One brake drags, one wheel drags	Sticking wheel cylinder pistons	Repair or replace wheel cylinders
	Swollen wheel cylinder cups	Repair or replace wheel cylinder, flush hydraulic system, and fill with approved brake fluid
	Sticking caliper piston	Repair or replace caliper
	Swollen caliper piston seal	Repair caliper, flush hydraulic system, and fill with approved brake fluid
	Defective brake hose or hydraulic tube preventing return of brake fluid	Replace defective hose or tube as necessary

DIAGNOSTIC CHART FOR VACUUM POWER-ASSIST UNITS

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Hard pedal	Faulty vacuum check valve	Do not repair or oil valve; replace it
	Engine intake manifold doesn't have sufficient (17 Hg to 20 Hg/432 - 508 mm) vacuum	Tune engine, repair and adjust and obtain proper vacuum
	Plugged breather in power unit	Clean or replace
	Vacuum hoses and line fittings plugged	Clean passages, or replace faulty parts
	External vacuum leaks in reserve tank and loose vacuum connections	Replace with new tank; tighten all vacuum connections
	Restricted power brake air filter	Wash filter in non-oil-based cleaning fluid; allow to dry before replacing, or install a new filter
	Rusted or dry vacuum piston	Lubricate vacuum piston, or replace the power brake unit
	Collapsed vacuum hose or dented tubing from intake manifold to power brake unit	Replace with new hose or tubing

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Pedal goes to floor	Low fluid level, or external hydraulic fluid leaks	Check for leaks, and repair as necessary; replenish fluid level
	Faulty residual check valve, primary cup, or contamination or rust	Flush system, replace defective parts, or replace power brake unit if defective
Pedal fails (or is slow) to return	Plugged breather in power brake unit	Clean or replace
	Plugged compensator port in power brake unit	Adjust pedal linkage, flush system, or replace power brake unit
	Piston stroke interference, or faulty residual check valve, or broken piston return spring, or sticky slide valve in power brake unit	Replace power brake unit; do not oil slide valve
	Excessive hydraulic seal friction in wheel cylinders and power brake unit	Replace wheel cylinders or power brake unit
Sensitive (grabby) brakes	Reaction diaphragm leakage, or sticky slide valve action, or closed or restricted atmospheric passage in vacuum piston assembly, or binding rubber seals in power brake unit	Replace power brake unit

DIAGNOSTIC CHART FOR HYDRAULIC POWER-ASSIST UNITS WITH MECHANICAL PUMPS

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Slow brake pedal return	Excessive seal friction in booster unit	Overhaul with new seal kit
	Spool return and/or piston return spring broken	Install appropriate new spring(s)
	Faulty spool action	Flush steering system while pumping brake pedal
	Clogged return line from booster to pump reservoir	Replace line
Excessive brake pedal effort	Power steering pump belt loose or broken	Tighten or replace belt
	Leaks in power steering, booster or accumulator connections, tube fittings, or hoses	Tighten fittings and/or replace tube seats and faulty parts
	External leakage at accumulator	Replace retainer and O-ring
	Power steering reservoir empty	Fill reservoir, and check for external leaks
	Leakage at booster flange vent due to faulty booster piston seal, or leakage between housing and cover due to faulty booster cover seal	Overhaul with appropriate new seal kit
	Faulty booster spool plug seal	Overhaul with new spool plug seal kit
	Faulty booster input rod seal with leakage at input rod end	Replace booster

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
System does not hold charge	Accumulator leak down or steering power-assist system contaminated	Flush steering system while pumping brake pedal
	Internal leakage in accumulator system	Overhaul system using accumulator rebuild and seal kit
Pedal vibrates and booster chatters	Loose power steering pump belt	Tighten belt
	Faulty spool operation due to contamination in system	Flush steering system while pumping brake pedal
	Low fluid level in power steering pump reservoir	Fill reservoir adequately, and check for external leaks
Brakes grab	Spool return spring damaged	Replace spring
	Faulty spool operation caused by contamination in system	Flush steering system while pumping brake pedal

DIAGNOSTIC CHART FOR HYDRAULIC POWER-ASSIST UNITS WITH ELECTRICAL PUMPS

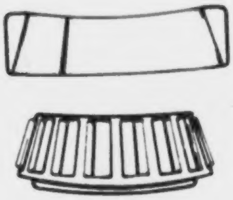
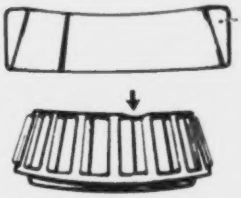
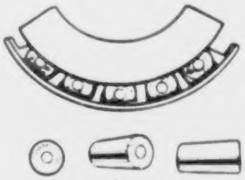
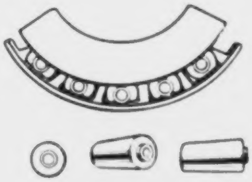
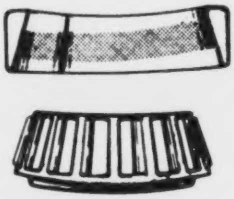
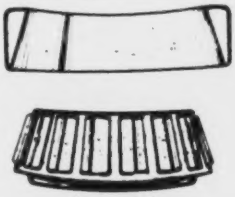
CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Brake warning light on after engine start	Parking brake applied	Temporarily release parking brake
	Partial failure in brake hydraulic pressure circuit	Troubleshoot circuit; repair or replace components as necessary
	Electrical failure	Check ignition, fuse, pressure switch, motor/ relay AC terminals, connectors, wiring; replace as necessary
	Low fluid in reservoir	Fill and bleed system
	Faulty warning light pressure switch	Check switch; replace as necessary
Excessive brake travel, hard brake pedal, excessive stopping distances, early wheel lock-up tendency	Partial failure in brake hydraulic pressure circuit	Troubleshoot pressure circuit; repair or replace components as necessary
Pump motor will not run	Electrical failure	Check ignition, fuse, pressure switch, motor/ relay AC terminals, connectors, wiring; replace as necessary

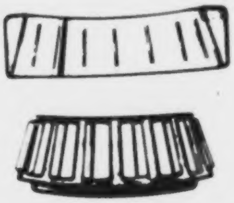
CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Pump motor runs, but does not shut off in 20 seconds	Low fluid in reservoir	Fill and bleed system
	Faulty power piston operation	Check reservoir port for backflow; replace power piston
	Low pump pressure	Check pressure line for obstruction; replace pump and motor if necessary
	High pump pressure	Replace switch if higher than normal; replace pump if lower than normal cutoff
Pump self-cycles without brake application	Incorrect accumulator precharge pressure	Test accumulator precharge pressure; if low, replace accumulator and recheck self-cycle
Pump self-cycles while holding steady brake application	Incorrect accumulator precharge pressure	Test accumulator precharge pressure; if low, replace accumulator and self-cycle
	Faulty power piston operation	Check reservoir port for fluid backflow; replace power piston
Pump reservoir does not cycle between full and nearly empty when accumulator is fully charged and fully depressurized	Air in fluid	Turn ignition ON and cycle pump 5 to 10 times to remove air by opening and closing bleeder valve
	Incorrect accumulator precharge pressure	Test accumulator precharge pressure; if low, replace accumulator
Pump reservoir fluid level does not cycle between half full and nearly empty at pressure switch limits	Pump reservoir not at FULL when accumulator is fully depressurized	Fill reservoir with brake fluid
	Incorrect accumulator precharge pressure	Test accumulator precharge pressure; if low, replace accumulator

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Fluid leakage	Worn or loose o-rings, grommets, seals, hoses, clamps, or connectors	Wipe components clean, check for leaks, replace damaged or worn components
	Loose reservoir cover or diaphragm	Repair or replace as necessary
	Excess fluid fill in reservoir when accumulator fully depressurized	Check pump pressure; replace switch if necessary
Pump cycle time at pressure switch limits exceeds 10 seconds	Air in system	Turn ignition ON and cycle pump 5 to 10 times to remove air by opening and closing bleeder valve
	Obstructed pump inlet or outlet	Flush system; replace pump and motor if necessary
	Abnormal pressure switch points	Replace pressure switch
	Faulty pump	Replace pump and motor

Adapted with permission of General Motors Corp.

WHEEL BEARING INSPECTION CHART

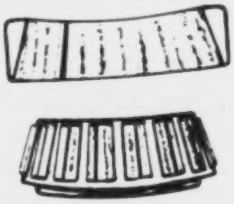
 **Good bearing**	 **Bent cage** Cage damage due to improper handling or tool usage. Replace bearing.
 **Galling** Metal smears on roller ends due to overheating, lubricant failure, or overload. Replace bearing—check seals and check for proper lubrication.	 **Abrasive step wear** Pattern on roller ends caused by fine abrasives. Clean all parts and housings, check seals and bearings and replace if leaking, rough, or noisy.
 **Misalignment** Outer race misalignment due to foreign object. Clean related parts and replace bearing. Make sure races are properly seated.	 **Indentations** Surface depressions on race and rollers caused by hard particles of foreign material. Clean all parts and housings, check seals and replace bearings if rough or noisy.



Brinelling

Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.

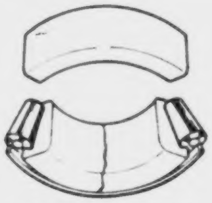
Replace bearing if rough or noisy



Etching

Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing.

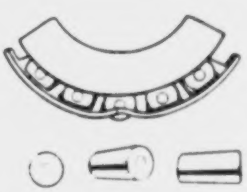
Replace bearing—check seals and check for proper



Cracked inner race

Race cracked due to improper fit, cocking, or poor bearing seats.

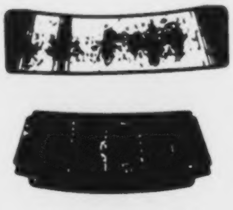
Replace bearing.



Bent cage

Cage damage due to improper handling or tool usage.

Replace bearing.



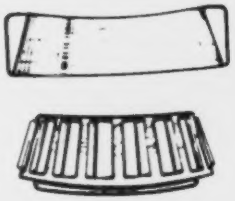
Heat discoloration

Heat discoloration can range from faint yellow to dark blue resulting from overload or incorrect lubricant.

Excessive heat can cause softening of races or rollers.

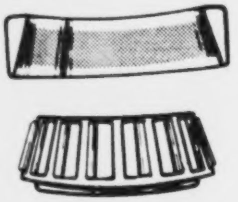
To check for loss of temper on races or rollers a simple file test may be made. A file drawn over a tempered part will grab and cut metal, whereas, a file drawn over a hard part will glide readily with no metal cutting.

Replaced bearings if overheating damage is indicated. Check seals and other parts



Cage wear

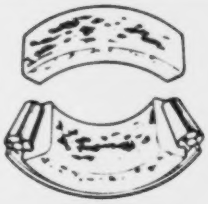
Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication. Check seals and replace bearings.



Abrasive roller wear

Pattern on races and rollers caused by fine abrasives.

Clean all parts and housings, check seals and bearings and replace if leaking, rough, or noisy.

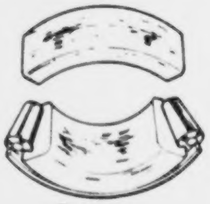


Smears

Smearing of metal due to slippage, slippage can be caused by poor fits, lubrication, overheating, overloads or handling damage.

Replace bearings, clean related parts and check for proper fit and lubrication.

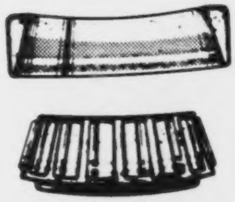
Replace shaft if damaged.



Frettage

Corrosion set up by small relative movement of parts with no lubrication.

Replace bearing. Clean related parts. Check seals and check for proper lubrication.

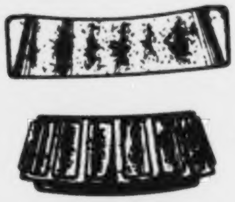


Stain discoloration

Discoloration can range from light brown to black caused by incorrect lubricant or moisture.

Reuse bearings if stains can be removed by light polishing or if no evidence of overheating is observed.

Check seals and related parts for damage.



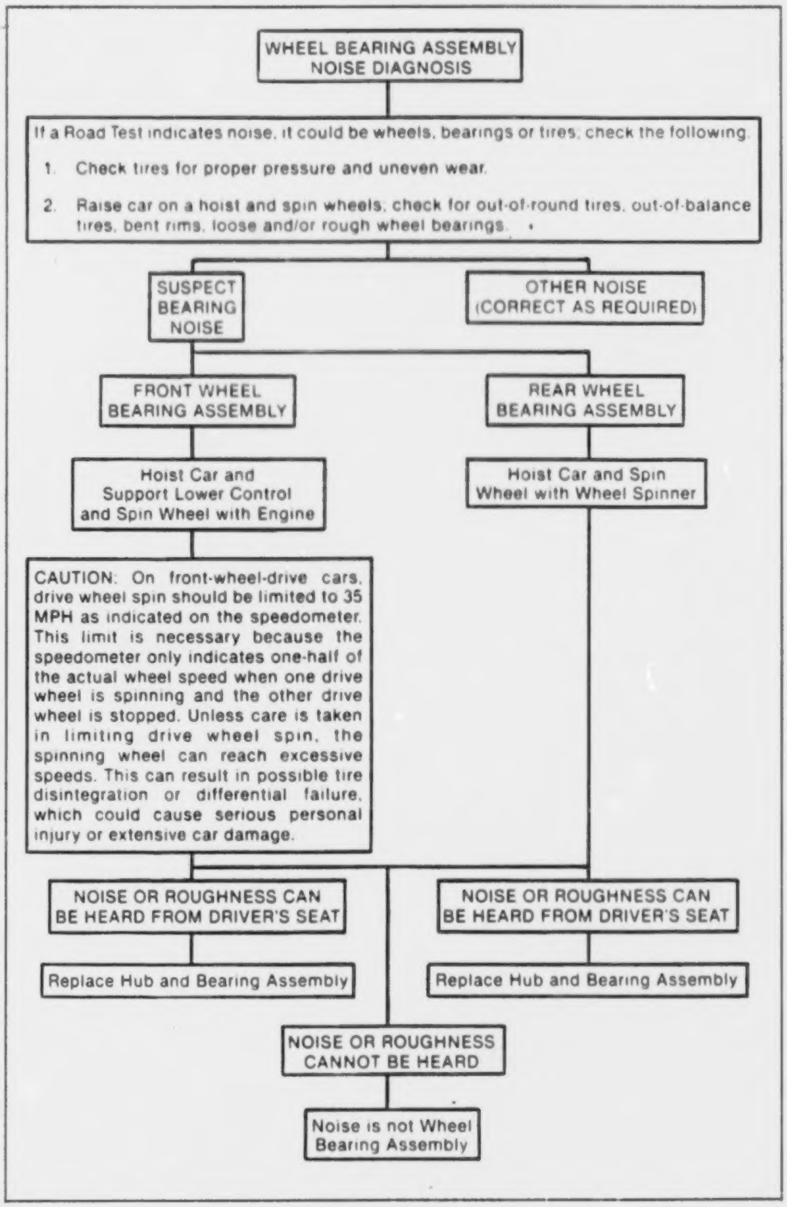
Fatigue spalling

Flaking of surface metal resulting from fatigue.

Replace bearing—clean all related parts.

Used with permission of General Motors Corp.

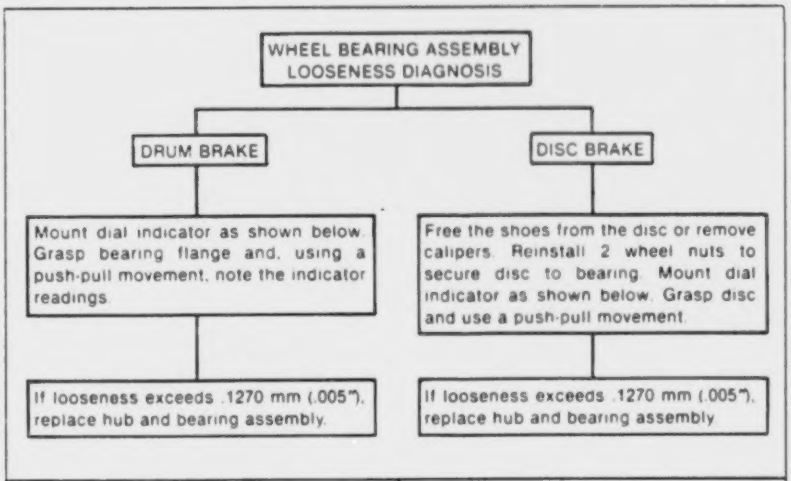
DIAGNOSTIC CHART FOR SEALED WHEEL BEARINGS


WHEEL BEARING ASSEMBLY NOISE DIAGNOSIS
SUSPECT BEARING NOISE
OTHER NOISE (CORRECT AS REQUIRED)
FRONT WHEEL BEARING ASSEMBLY
REAR WHEEL BEARING ASSEMBLY
Hoist Car and Support Lower Control and Spin Wheel with Engine
Hoist Car and Spin Wheel with Wheel Spinner
NOISE OR ROUGHNESS CAN BE HEARD FROM DRIVER'S SEAT
NOISE OR ROUGHNESS CAN BE HEARD FROM DRIVER'S SEAT
Replace Hub and Bearing Assembly
Replace Hub and Bearing Assembly
NOISE OR ROUGHNESS CANNOT BE HEARD
Noise is not Wheel Bearing Assembly

If a Road Test indicates noise, it could be wheels, bearings or tires; check the following.

1. Check tires for proper pressure and uneven wear.
2. Raise car on a hoist and spin wheels; check for out-of-round tires, out-of-balance tires, bent rims, loose and/or rough wheel bearings.

CAUTION: On front-wheel-drive cars, drive wheel spin should be limited to 35 MPH as indicated on the speedometer. This limit is necessary because the speedometer only indicates one-half of the actual wheel speed when one drive wheel is spinning and the other drive wheel is stopped. Unless care is taken in limiting drive wheel spin, the spinning wheel can reach excessive speeds. This can result in possible tire disintegration or differential failure, which could cause serious personal injury or extensive car damage.



WHEEL BEARING ASSEMBLY LOOSENESS DIAGNOSIS

DRUM BRAKE

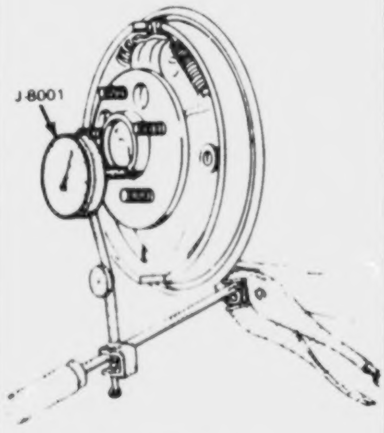
Mount dial indicator as shown below. Grasp bearing flange and, using a push-pull movement, note the indicator readings.

If looseness exceeds .1270 mm (.005"), replace hub and bearing assembly.

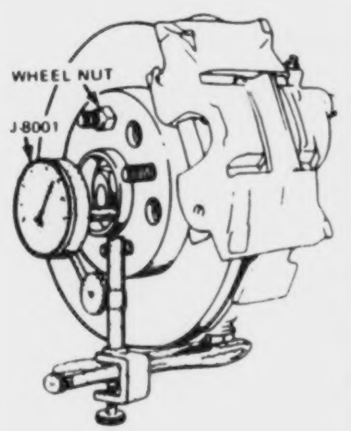
DISC BRAKE

Free the shoes from the disc or remove calipers. Reinstall 2 wheel nuts to secure disc to bearing. Mount dial indicator as shown below. Grasp disc and use a push-pull movement.

If looseness exceeds .1270 mm (.005"), replace hub and bearing assembly.



EXAMPLE OF MOUNTING
DIAL INDICATOR—DRUM BRAKES



EXAMPLE OF MOUNTING
DIAL INDICATOR—DISC BRAKES

Used with permission of General Motors Corp.

WHEEL BEARING PROBLEMS

Listed below are driving problems that may result from defective or improperly installed wheel bearings. Problems that result from defective wheel bearings can be solved only by replacing the bearing. Those caused by improper installations must be corrected by making a proper installation, such as through adjusting the bearing. Often improper installations will lead to bearing damage, meaning that the bearing must be replaced anyway. Many of the driving problems listed may be caused by other conditions, such as worn suspension parts or defective brakes. The service specialist should use this information as just another clue in analyzing problem situations.

Loose wheel bearings can cause

- Vehicle to pull to one side
- Chatter
- Uneven braking
- Shimmy
- Too much play in the steering system

Overtightened wheel bearings can cause

- Noise
- Uneven braking
- Overheating of the wheel and bearing
- Vehicle to pull to one side

Damaged wheel bearings can cause

- Noise
- Shimmy in affected wheel
- Vehicle to pull to one side

Worn wheel bearings can cause

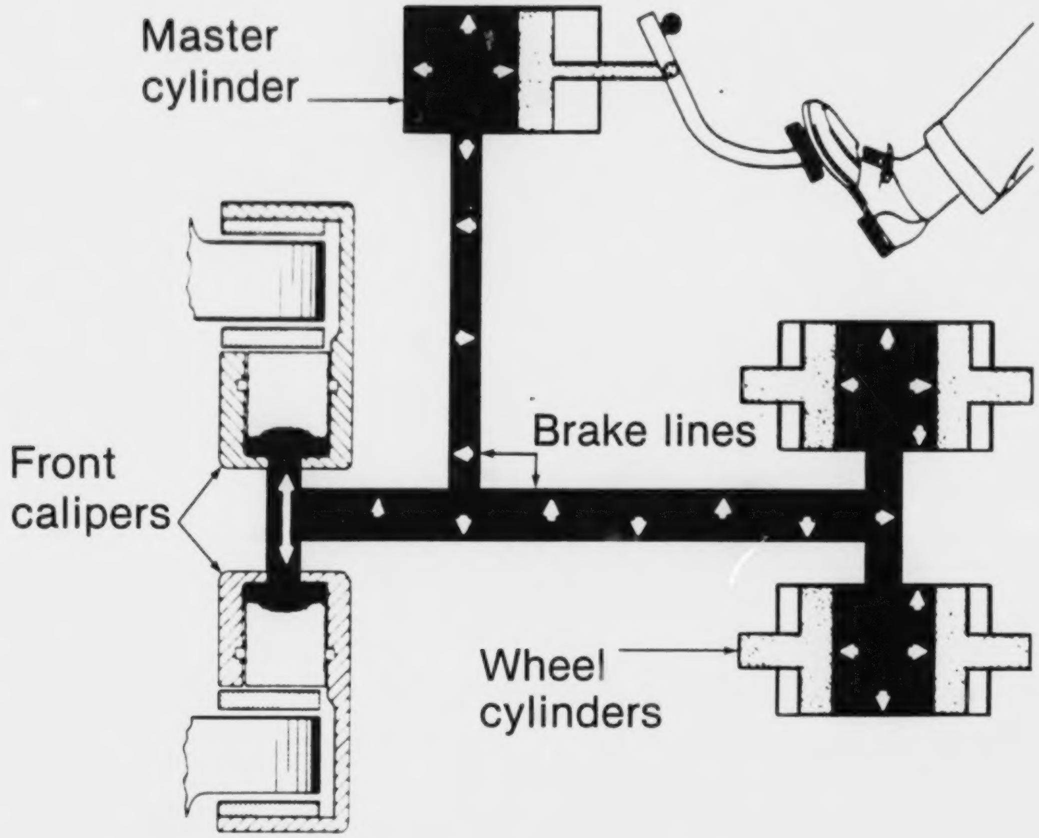
- Noise

NOTE: Excessively worn bearings may give the same indications as loose bearings.

DIAGNOSTIC CHART FOR STOP LIGHTS

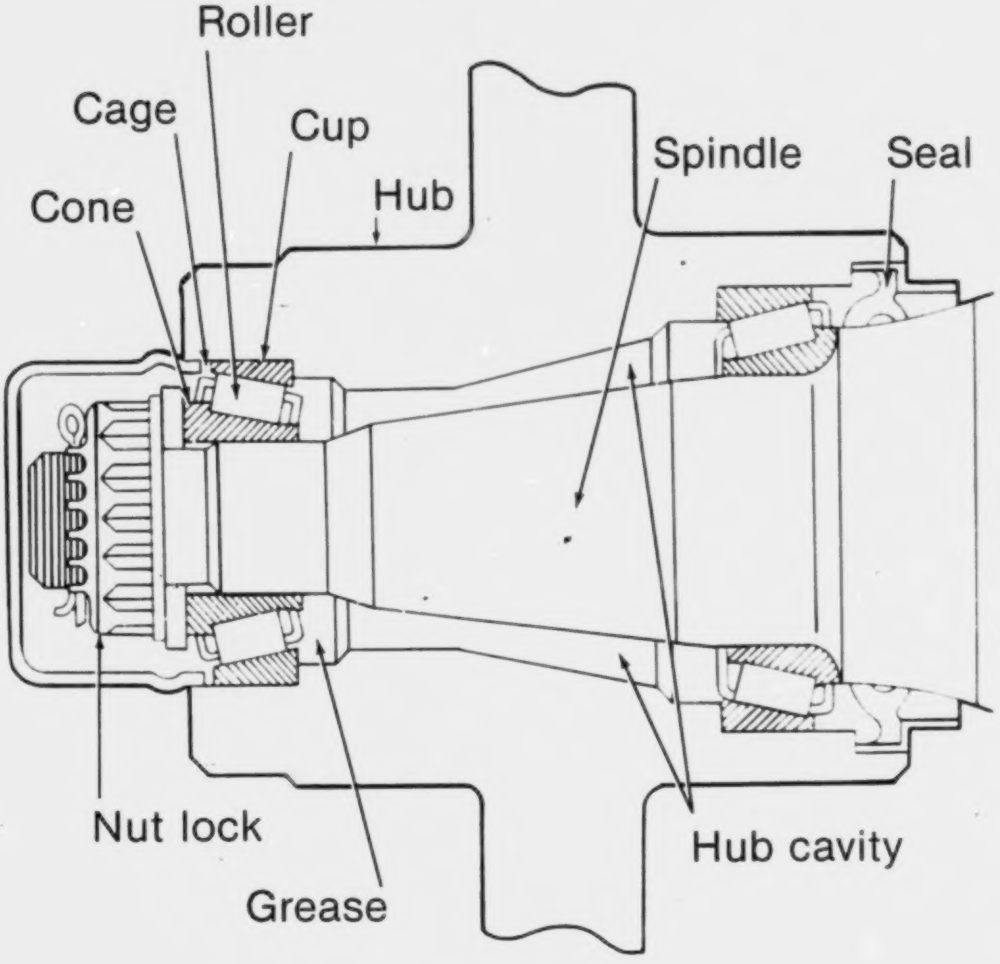
CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
One bulb inoperative	Bulb burned out	Replace bulb
One side inoperative	Loose connection, open wiring, defective bulb	Turn on directional signal; if light does not operate, check bulbs; if bulbs are okay, secure all connections; if light still does not operate, use test light and check for open wiring
	Defective directional signal switch or cancelling cam	If light will operate by turning on directional signal, switch is not centering properly during cancelling operation; replace defective cancelling cam or directional signal switch
All lights inoperative	Blown fuse	Replace fuse; if new fuse blows, repair short-to-ground in circuit between fuse and lights
	Stop switch maladjusted or defective	Check stop switch; adjust or replace as necessary
Lights will not turn off	Stop switch maladjusted or defective	Readjust switch; if switch still malfunctions, replace it

Hydraulic Brake System Operation


Master cylinder
Brake lines
Front calipers
Wheel cylinders

Used with permission of General Motors Corp.

Tapered Roller Wheel Bearing

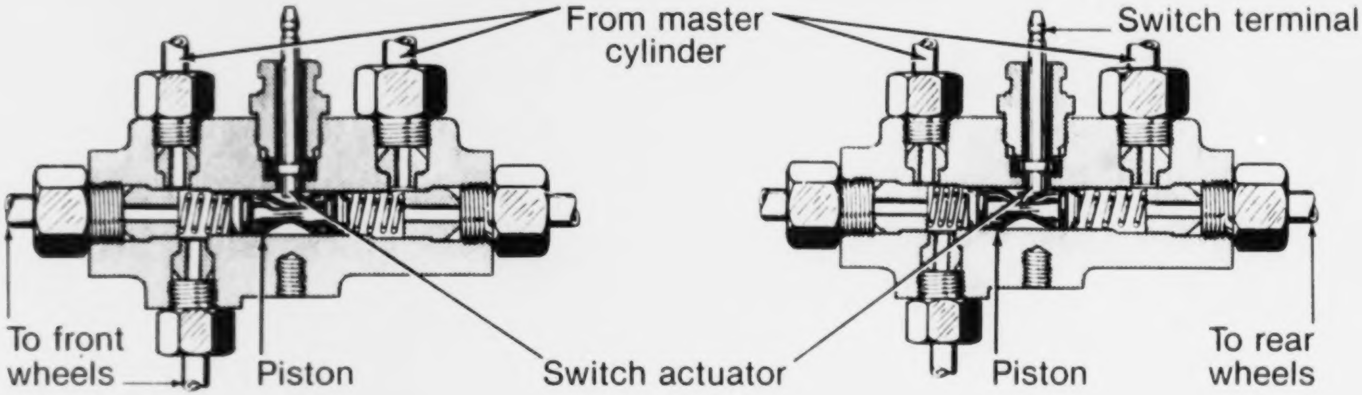

Roller
Cage
Cup
Cone
Hub
Spindle
Seal
Nut lock
Grease
Hub cavity

Used with permission of Chrysler Corp.

Operation of Pressure Differential Valve

Valve in normal position

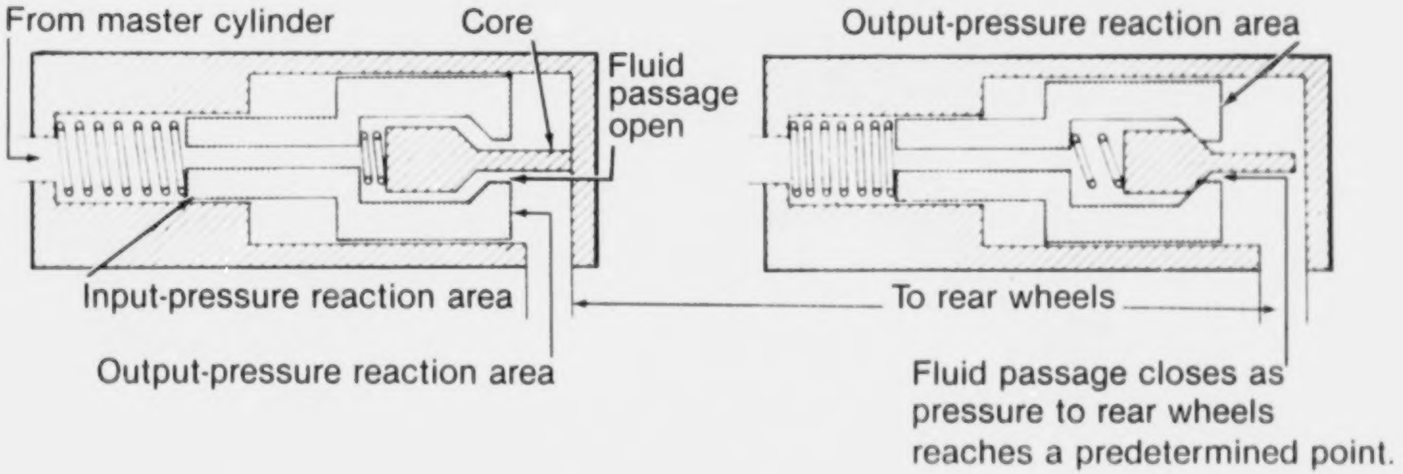
Valve in failed position


From master cylinder
Switch terminal
To front wheels
Piston
Switch actuator
Piston
To rear wheels

Equal pressure in both front and rear hydraulic systems

Pressure in the front hydraulic system is low, allowing the higher pressure in the rear system to move the switch piston to turn on the brake warning light.

Operation of Proportioning Valve



Released position

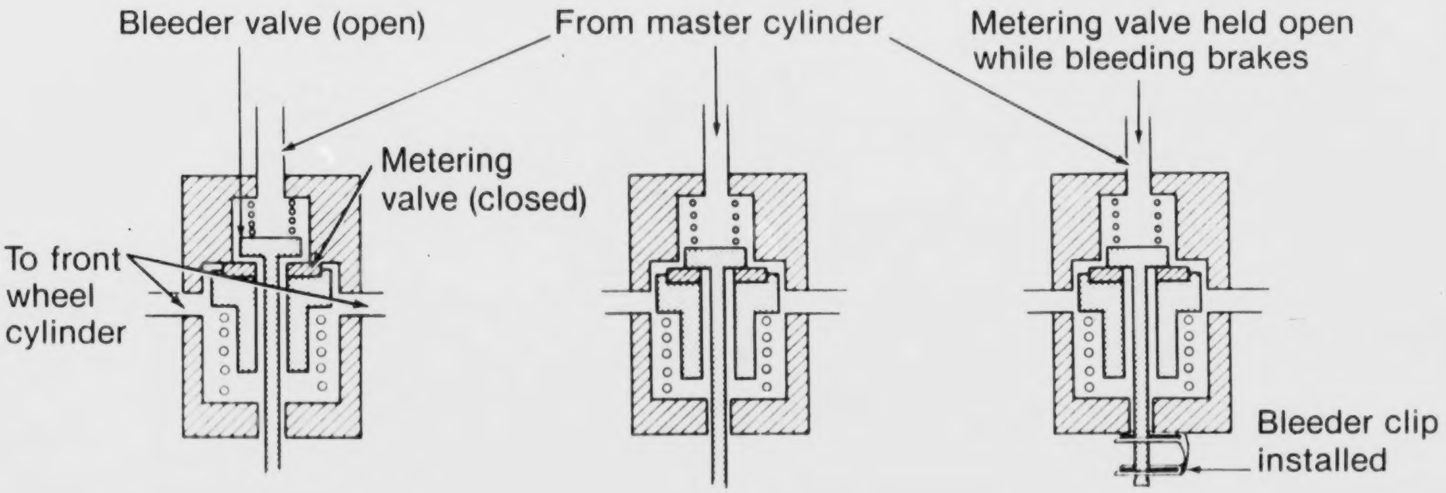
High-pressure position

From master cylinder
Core
Fluid passage open
Input-pressure reaction area
Output-pressure reaction area
Output-pressure reaction area
To rear wheels
Fluid passage closes as pressure to rear wheels reaches a predetermined point.

Proportioning valve is controlling hydraulic pressure to rear wheels to prevent tire skid as weight of vehicle shifts from rear to front wheels on hard stops.

Operation of Metering Valve

Released position **Applied position** **Bleeder position**

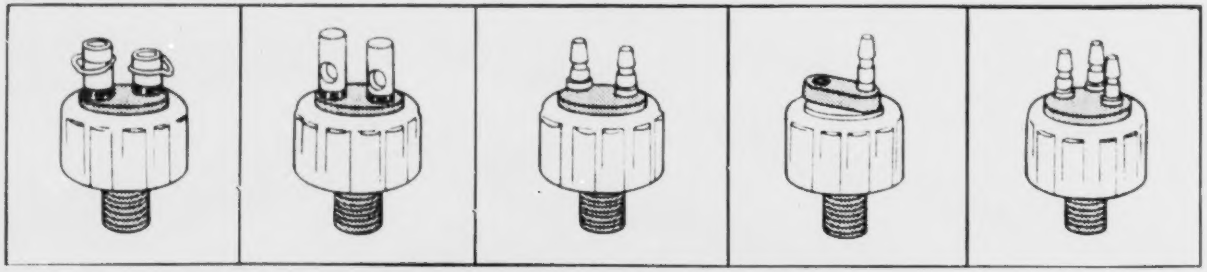

Bleeder valve (open)
From master cylinder
Metering valve held open while bleeding brakes
Metering valve (closed)
To front wheel cylinder
Bleeder clip installed

Bleeder valve remains open under 4 psi to allow fluid to expand and contract.

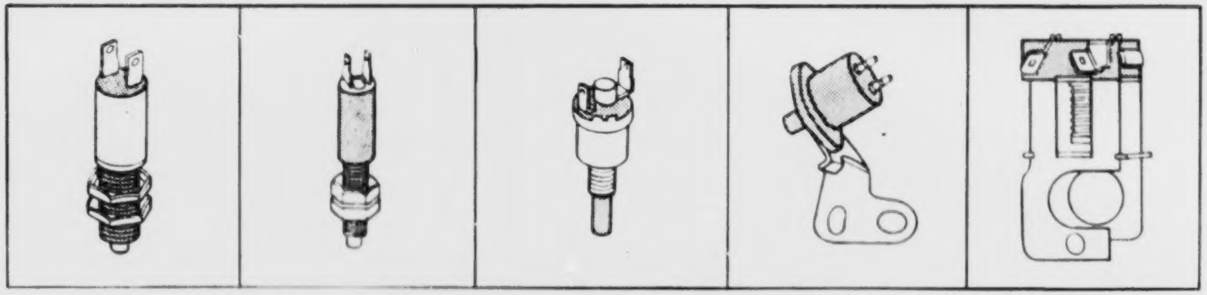
Pressure above approximately 150 psi opens the metering valve to allow pressure to front brakes.

Metering valves that have a rubber cover over the bleeder valve will require the valve to be pushed in for bleeding.

Stop Light Switch Designs



Hydraulically operated



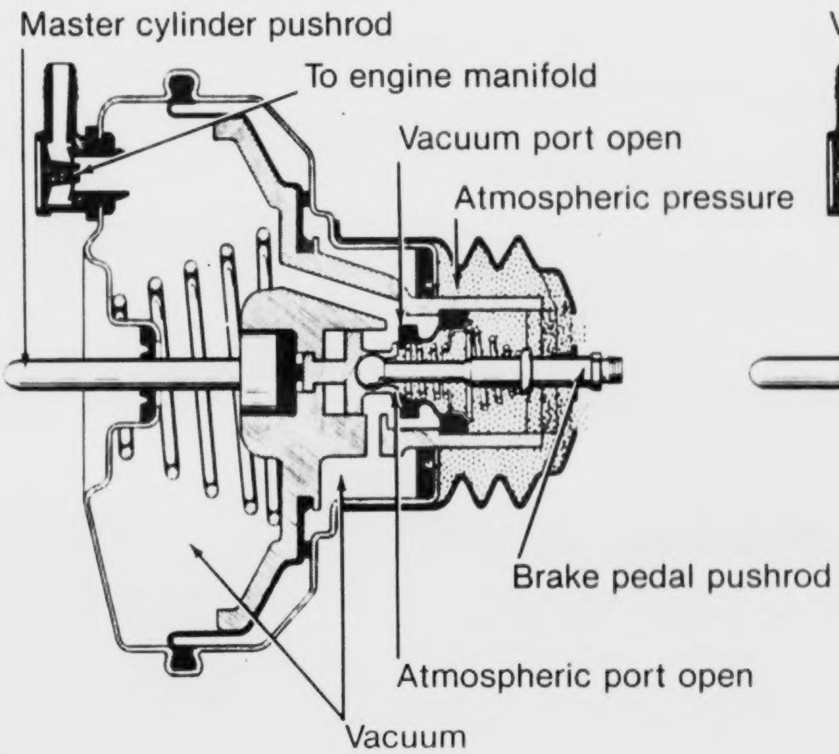
Mechanically operated

Used with permission of Allied Aftermarket

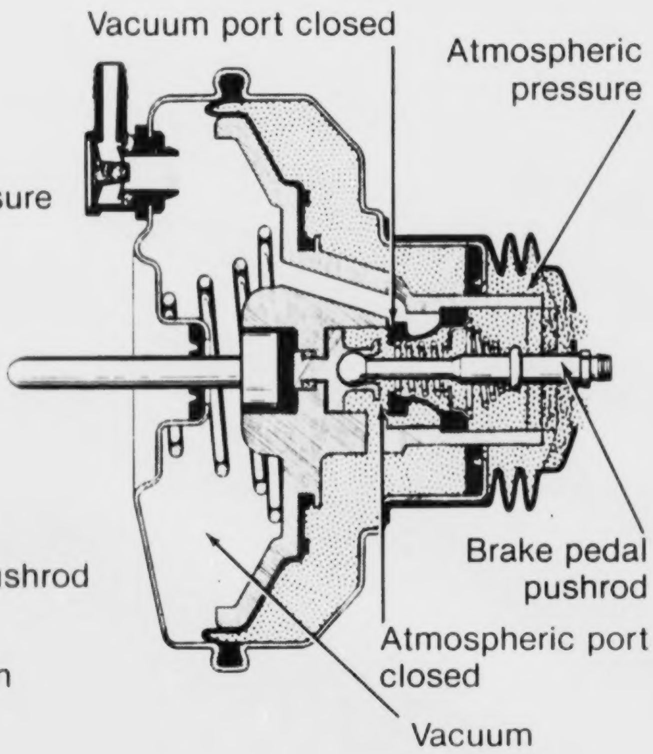
Operation of Vacuum-Suspended Power-Assist Unit

TRANSPARENCY MASTER 7 · Brakes Specialist
CIMC - I - 113

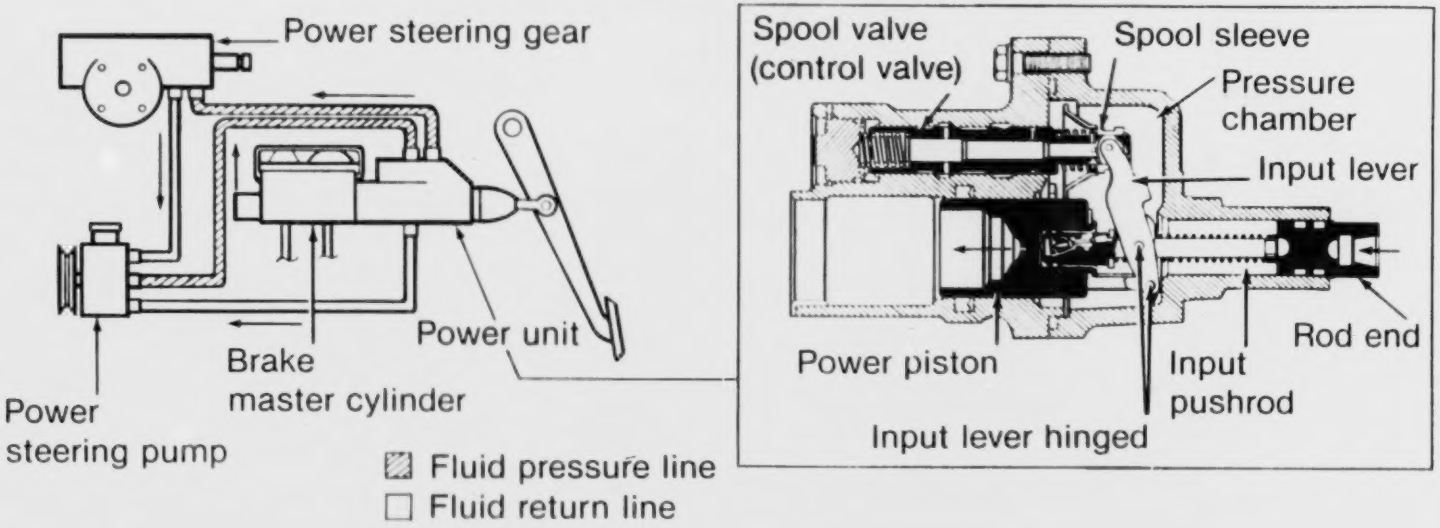
Booster in the released position


Master cylinder pushrod
To engine manifold
Vacuum port open
Atmospheric pressure
Brake pedal pushrod
Atmospheric port open
Vacuum

Booster in the applying position


Vacuum port closed
Atmospheric pressure
Brake pedal pushrod
Atmospheric port closed
Vacuum

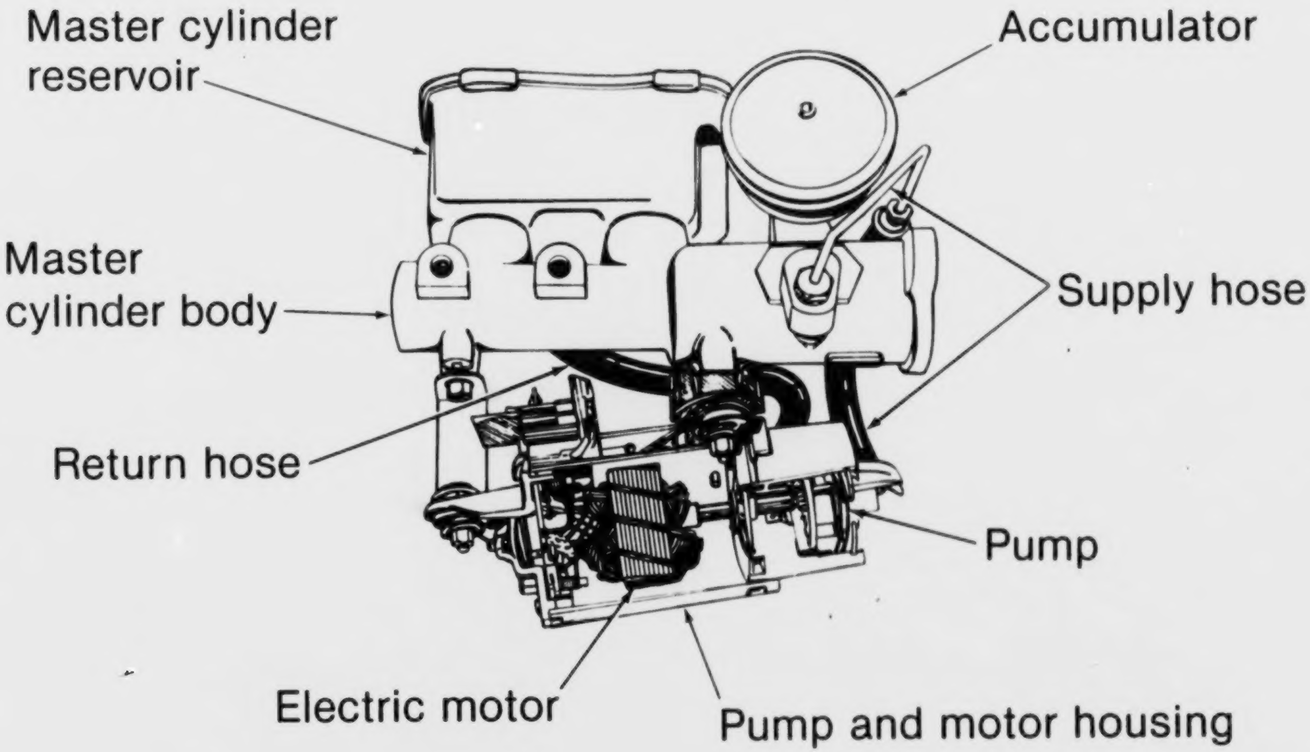
Operation of Hydraulic Power-Assist Unit (Mechanical Pump)


Power steering gear
Power unit
Brake master cylinder
Power steering pump
Spool valve (control valve)
Spool sleeve
Pressure chamber
Input lever
Rod end
Input pushrod
Power piston
Input lever hinged
▨ Fluid pressure line
☐ Fluid return line

1. Pedal pushes on rod end.
2. Spool valve (control valve) allows hydraulic fluid from power steering pump to enter pressure chamber.
3. Hydraulic fluid under pressure actuates power piston.
4. Power piston acts on master cylinder to provide power assist.

Used with permission of Ford Motor Co

Operation of Hydraulic Power-Assist Unit (Electrical Pump)


Master cylinder reservoir
Accumulator
Master cylinder body
Supply hose
Return hose
Pump
Electric motor
Pump and motor housing

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

ACTIVITY SHEET

Development of:
READING SKILLS
ORAL COMMUNICATION SKILLS
INTERPERSONAL OR RELATING SKILLS

- Introduce the assignment to the students by discussing why reading, oral communication, and interpersonal or relating skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  — Interpreting graphics & symbols

  ORAL COMMUNICATION SKILLS

  — Working effectively in a group

  INTERPERSONAL OR RELATING SKILLS

  — Interacting with co-workers

  — Participating in group activities

- If students have difficulty interpreting graphics and symbols:

  — Review the graphics, identifying landmarks and actions taking place.

  — Review and compare types of illustrations such as line drawings, photographs, exploded views, and broken views.

- If students have difficulty working or participating effectively in a group:

  — Stress the importance of taking a part in the discussion and stating ideas.

  — Remind them to listen respectfully to the ideas and opinions of others.

  - Stress the importance of having a positive attitude.
  - Ask them to work constructively to set and achieve the goals of the group.
- If students have difficulty interacting with co-workers:
  - Discuss the importance of interacting constructively with clients, supervisors, co-workers, teachers, and fellow students.
  - Have the student identify the objective of the interaction and suggest possible methods of achieving that objective.
- If students have difficulty participating in group activities:
  - Discuss the goals of the group.
  - Define each student's responsibilities within the group.
  - Discuss carrying one's fair share of responsibilities.
  - Encourage students to treat each other with courtesy and respect.
  - Explain that everyone's input is important.
  - Stress using active listening skills.

ACTIVITY SHEET

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

Name ______________________________ Score ________

ANSWER GENERAL QUESTIONS ABOUT BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

INTRODUCTION

To become certified as a Brakes Specialist, you must pass a test on the brake system compiled by the National Institute for Automotive Service Excellence (ASE). The certification test covers all aspects of a vehicle's braking system. This activity sheet covers only brake hydraulic system and wheel bearings but contains realistic questions similar in content and style to those found on the actual ASE certification test.

DIRECTIONS

Functional Reading Skills
- Interpret graphics and symbols

Interactive Communication Skills
- Work effectively in a group

General Relating Skills
- Interact with co-workers
- Participate in group activities

Read each of the following study questions twice. The second time you may notice a key word that you overlooked the first time. Every word in the question is important and may provide a clue to the right answer. Select the answer that is *most* correct, and write its letter in the answer blank.

After you have completed this activity sheet, get together with a group of your classmates and use the answer key provided by your instructor to check your answers. Each correct answer counts 4 points for a total score of 100 percent. Pay particular attention to those questions that you answered incorrectly. Do your incorrect answers indicate an area of weakness? Were your incorrect answers caused by carelessness or lack of knowledge? What steps must you take to improve your percentage of correct answers?

Discuss your answers with your group and with the class as a whole.

_____ 1. Some automobiles with front disc brakes use a metering valve. When bleeding this type of brake with a pressure tank, which of the following apply?

a. The metering valve plunger must be pushed to the closed position
b. The metering valve has no effect on bleeding brakes if a dual master cylinder is used
c. The metering valve plunger must be held open
d. Both a and b

_____ 2. The outer bearing race (cup) is spinning (turning) in the front hub. The customer should be sold:

a. A new cup and bearing
b. A new cup only
c. A new hub only
d. A new cup, bearing, and hub

_____ 3. What quick method can be used to prove that the compensating port in the master cylinder is open?

a. Check free pedal measurement
b. Remove filler cap, press on brake pedal, and observe fluid geyser
c. Bleed wheel cylinder closest to master cylinder and observe fluid geyser
d. Both b and c

_____ 4. When bleeding the brakes, you would normally start with the caliper:

a. Closest to master cylinder
b. Farthest from master cylinder
c. On same side as master cylinder
d. On right front side

_____ 5. Most combination brake systems use a proportioning valve. Its purpose is to:

a. Reduce pressure at the rear brakes
b. Reduce pressure at the front brakes
c. Act as a safety valve with the dual-type master cylinder
d. Act as a cutoff valve in the event of front or rear system failure

_____ 6. When replacing a hydraulic brake line, which of the following is the correct procedure?

a. Use seamless copper tubing with single-flared ends
b. Cut out bad section, install copper tubing using a union
c. Use single-length double-flared steel or copper tubing
d. None of the above

_____ 7. An automobile is equipped with a disc/drum system. The rear wheels skid prematurely under hard brake application. Which of the following is the *most likely* cause?

a. Plugged compensating port
b. Defective proportioning valve
c. Defective power-assist unit
d. Trapped air in hydraulic system

_____8 . A customer brings in an automobile and relates that the warning light on the dash is on. You examine the circuit and find that it is activated by a switch without centering springs. Which of the following must you do in order to open the circuit and center the terminal in the switch?

a. Remove the switch terminal from the switch body
b. Bleed the system
c. Nothing, as the terminal will automatically center itself
d. Pump the brake pedal

_____ 9. The stop lights on a customer's vehicle are on all the time. Which of the following is a possible cause?

a. Low fluid level
b. Binding brake pedal
c. Open circuit
d. Ignition on

_____10. Which of the following is not an acceptable part of the process of cleaning bearing assemblies?

a. Wipe excess grease off each bearing assembly with a rag
b. Soak each assembly in gasoline
c. Scrub each assembly with parts-cleaning brush
d. Blow out any remaining dirt particles and solvent from each assembly with a low-pressure nozzle

ACTIVITY SHEET ANSWERS

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

1. c
2. d
3. b
4. b
5. a
6. d
7. b
8. b
9. b
10. b

ASSIGNMENT SHEET 1

Development of:
READING SKILLS
SCIENCE SKILLS
CREATIVE THINKING/PROBLEM SOLVING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, science, creative thinking/problem solving, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  — Using in-book references

  SCIENCE SKILLS

  — Investigating/applying technology

  CREATIVE THINKING/PROBLEM SOLVING SKILLS

  — Identifying underlying causes

  — Transferring knowledge/training to new situations

  EMPLOYABILITY SKILLS

  — Mastering a specific job task/procedure

- If students have difficulty using in-book reference tools:

  — Show students various in-book reference tools, including table of contents, supplements, terms and definitions, charts, illustrations, and unit objective statements. Identify the content of each and have students identify how each can be used for easy access to text information.

  — Encourage students to use bookmarks or other devices to mark most-used in-book references.

- Explain to students that books are "random access" tools meaning the information in them is accessible in any order. Compare books to items which are not random access such as cassette tapes or video films.
- Have students create their own in-book references by keeping word lists, glossaries, time lines, or lecture notes and relating each piece of information to its textbook location.

- If students have difficulty investigating/applying technology:
  - Review characteristics and functions of brake hydraulic systems and wheel bearings, parts, and components.
  - Review indications for and use of various tools.
  - Review measurements which can be made and what the measurements indicate.
  - Review how engine systems are related.
  - Review how system use and malfunction are indicated.
- If students have difficulty identifying underlying causes:
  - Review the relationships between system components.
  - Review the effects of most common system malfunctions.
  - Move component-by-component or part-by-part through the system, reviewing the purpose of each component or part and asking the student to suggest the effect of part/component failure.
  - Review the use of diagnostic charts and tools.
- If students have difficulty transferring knowledge/training to new situations:
  - Review the pertinent training. Compare the new situation to the training situation.
  - Examine ways in which training can be used in the new situation.

- If students have difficulty mastering a specific job task/procedure:

  — Emphasize the fact that practice makes a person proficient and proficiency makes a person confident.

  — Suggest they study each component of the procedure to determine which area is causing difficulty.

  — Review the entire procedure.

  — Team them with proficient students or professionals to practice the procedure.

ASSIGNMENT SHEET 2

Development of:
READING SKILLS
SCIENCE SKILLS
CREATIVE THINKING/PROBLEM SOLVING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, science, creative thinking/problem solving, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  — Using in-book references

  SCIENCE SKILLS

  — Investigating/applying technology

  CREATIVE THINKING/PROBLEM SOLVING SKILLS

  — Identifying underlying causes

  EMPLOYABILITY SKILLS

  — Mastering a specific job task/procedure

- For additional suggestions on teaching basic skills, refer to suggestions for Assignment Sheet 1.

ASSIGNMENT SHEET 1

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

Name ______________________________ Score __________

OBJECTIVE 21

Diagnose brake system hydraulic and wheel bearing problems.

INTRODUCTION

Proper diagnosis of a vehicle's hydraulic brake system is extremely important. In order for a vehicle's brake system to operate properly, the hydraulic system must be trouble-free and in good repair. Service to the hydraulic system is quite simple, generally requiring the Brakes Specialist to adjust brake fluid levels, bleed the system, or replace faulty components. In order to service the hydraulic system, however, the Brakes Specialist must first be able to determine the cause of the problem and the corrective action needed.

DIRECTIONS

Research and Reference Skills
- Use in-book reference tools

General Science Skills
- Investigate/apply technology

Cognitive Activity Skills
- Identify underlying causes
- Transfer knowledge/training to new situations

Given below and on the following pages are "customer complaints" and problems that indicate hydraulic or wheel bearing trouble. Normally, the specialist would verify the customer's complaint by test driving the vehicle to check brake performance and to determine the need for service. Since a test drive is not practical here, base your diagnosis on the customer's descriptions or on the problems described and refer to the diagnostic charts in Supplements 1, 5, 6, and 7 to determine possible causes and the corrective actions needed.

1. **Customer complaint:** When I apply the brakes, the car pulls to the right. I can't get a straight-line stop. (Four-wheel disc brake vehicle)

   Possible cause(s): ______________________________

   ____

   ____

   ____

   Corrective action(s): ______________________________

   ____

   ____

   ____

Job Acquisition/
Development Skills
- Master specific job task/procedure

2. **Customer complaint:** There is something wrong with the brake pedal. It is so hard that I have to really tromp on it in order to stop the car.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ____________________________

____

____

____

3. **Customer complaint:** My husband changed the brake fluid last week, and ever since, the brake pedal has felt funny—kind of bouncy and mushy.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ____________________________

____

____

____

4. **Customer complaint:** When I step on the brake pedal, the pedal doesn't seem to go down as far as it used to.

   Possible cause(s): ________________________________

   ____

   ____

   ____

   Corrective action(s): ______________________________

   ____

   ____

   ____

5. **Customer complaint:** I just had my brakes adjusted last week, but now it feels as though the brakes are still on a little, even after I remove my foot from the brake pedal.

   Possible cause(s): ________________________________

   ____

   ____

   ____

   Corrective action(s): ______________________________

   ____

   ____

   ____

6. **Customer complaint:** I can hear chatter when driving.

   Possible cause(s): ________________________________

   ____

   ____

   ____

Corrective action(s): ______________________________

____

____

____

7. **Problem:** You have removed the wheel bearings, and upon inspection you discover that the roller ends contain galling (metal smears).

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ______________________________

____

____

____

8. **Problem:** When servicing the wheel bearings, you notice that the cage outside diameter shows wear.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ______________________________

____

____

____

9. **Problem:** Upon inspection of the wheel bearing assembly, you discover a cracked inner race.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ______________________________

____

____

____

10. **Problem:** You are inspecting the wheel bearings and discover frettage (corrosion) on the race.

Possible cause(s): ______________________________

____

____

____

Corrective action(s): ______________________________

____

____

____

ASSIGNMENT SHEET 2

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

Name ______________________________ Score ________

OBJECTIVE 22

Diagnose power-assist unit problems.

INTRODUCTION

Power brakes have gained wide acceptance with car buyers because of the reduced driver effort that such brakes require. Modern power-assist units have proven to be relatively trouble-free, but certain brake problems can be caused by malfunctioning or defective power-assist units.

Remember that the hydraulic and mechanical problems found in conventional brake systems also may occur in power brake systems, and so the problems associated with conventional systems may also have to be checked for during the inspection of the power-assist unit.

DIRECTIONS

Research and Reference Skills
- Use in-book reference tools

General Science Skills
- Investigate/apply technology

Cognitive Activity Skills
- Identify underlying causes

The following questions are multiple-choice-type questions, each with three possible answers. Read each question carefully and then select the answer that is *most* correct. Write the correct letters in the blanks. Use Supplements 2 through 4 to help you with your diagnosis.

____ 1. A vehicle is equipped with hydraulic power brakes using a mechanical pump. The owner says that excessive brake pedal effort is required to stop the vehicle. Which of the following is a possible cause?

a. Excessive seal friction in booster
b. Broken spool return spring
c. Loose or broken power steering pump belt

_____ 2. A vehicle is equipped with vacuum power brakes. The owner says that excessive pedal effort is required when the brakes are applied. Which of the following would not be a likely cause?

a. Plugged breather in power brake unit
b. Broken piston return spring
c. Collapsed vacuum hose or dented tubing from intake manifold to power brake unit

Job Acquisition/ Development Skills
- Master specific job task/procedure

_____ 3. You are servicing a 1987 T-Bird with an electrically driven hydraulic power-assist unit and find that the pump cycle time at pressure switch limits exceeds 10 seconds. Which of the following is a possible cause?

a. Incorrect accumulator precharge pressure
b. Electrical failure
c. Air in system

_____ 4. You have just inspected a vehicle with vacuum power brakes and determined that a sticky slide valve in the power brake unit was the cause of the brake pedal failing to release. Which of the following would be the proper corrective measure?

a. Replace power brake unit
b. Oil slide valve
c. Wash slide valve and replace brake fluid

_____ 5. You have just determined that the pedal vibration on a vehicle equipped with hydraulic brakes using a mechanical pump was caused by low fluid level in the power steering pump reservoir. Which of the following would be the proper corrective measure?

a. Flush steering system while pumping brake pedal
b. Fill reservoir with brake fluid and check for leaks
c. Fill reservoir with power steering fluid and check for leaks

_____ 6. While road testing a vehicle equipped with a hydraulic power-assist unit using a mechanical pump to verify a customer complaint, you notice that the brakes grab. Which of the following would be a possible cause?

a. Broken spool return spring
b. Broken power piston return spring
c. Loose power steering pump belt

_____ 7. While servicing a late-model vehicle with an electrically driven hydraulic power-assist unit, you find that the pump cycles while holding steady brake application and that there is fluid backflow from the reservoir port. Which of the following is a possible cause and corrective action?

a. High pump pressure; replace pressure switch
b. Faulty power piston operation; replace piston
c. Air in system; bleed hydraulic system

_____ 8. While servicing a vehicle equipped with hydraulic power brakes using a mechanical pump, you discover external leakage at the accumulator welds. Which of the following conditions would this leakage cause?

a. Brakes grab
b. Excessive brake pedal effort
c. Brake pedal goes to the floor

_____ 9. While servicing a vehicle equipped with vacuum power brakes, you discover leakage at the reaction diaphragm. Which of the following conditions would this defect cause?

a. Sensitive (grabby) brakes
b. Pedal fails or is slow to release
c. Hard pedal

_____10. You are inspecting a 1987 Cadillac equipped with a Powermaster (electrically driven power-assist unit). You find that low pump pressure is the cause of the pump motor running but not shutting off in 20 seconds. Which of the following would be the proper corrective measure?

a. Check pressure line for obstruction; replace pump and motor if necessary
b. Replace pressure switch
c. Check reservoir port for backflow; replace power piston

_____11. A vehicle is equipped with vacuum power brakes. You discover a rusted vacuum piston. Which of the following would be the proper corrective measure?

a. Replace master cylinder
b. Recondition piston bore
c. Lubricate piston or replace power brake unit

_____12. The owner of a vehicle with vacuum power brakes. complains that the brake pedal stays down after she takes her foot off of it. Which of the following is a possible cause?

a. Rusted or dry vacuum piston
b. Plugged compensator port in power brake unit
c. Improperly adjusted brake pedal free play

_____13. A customer brings in a vehicle equipped with a hydraulic power-assist unit using a mechanical pump. The customer says that he has to apply a lot of pressure to the brake pedal to bring the car to a stop. Which of the following is a possible cause?

a. Power steering reservoir empty
b. Clogged return line from booster to pump reservoir
c. Slow brake pedal return

_____14. When servicing an electrically driven hydraulic power-assist unit, you find that the pump reservoir fluid level does not cycle between half full and nearly empty at the pressure switch limits. Which of the following is a possible cause?

a. Faulty pump
b. Faulty power piston operation
c. Pump reservoir not at FULL when accumulator is fully depressurized

_____15. A vehicle is equipped with vacuum power brakes. You discover a faulty vacuum check valve. Which of the following would be the proper corrective measure?

a. Replace the valve
b. Repair and oil the valve
c. Replace the power brake unit

ASSIGNMENT ANSWERS

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

ASSIGNMENT SHEET 1

1. Possible cause(s): (a) sticking caliper piston, (b) sticking wheel cylinder piston, (c) loose, overtightened, damaged or excessively worn bearings

   Corrective action(s): (a) repair or replace caliper, (b) repair or replace wheel cylinder, (c) inspect and adjust or replace wheel bearings

2. Possible cause(s): (a) clogged master cylinder tubes or hoses, (b) frozen master cylinder pistons

   Corrective action(s): (a) replace tubes or hoses as necessary, (b) repair or replace master cylinder

3. Possible cause(s): (a) poor-quality brake fluid would be most likely cause, but may also be caused by (b) weak brake hoses that expand under pressure or (c) air in system

   Corrective action(s): (a) flush system and fill with approved brake fluid, (b) replace defective hoses, (c) bleed system

4. Possible cause(s): (a) sticking wheel cylinder piston, (b) plugged master cylinder compensating ports, (c) swollen master cylinder cups

   Corrective action(s): (a) repair or replace wheel cylinder, (b) repair or replace master cylinder, (c) repair or replace master cylinder, flush hydraulic system, and fill with approved brake fluid

5. Possible cause(s): (a) soft or swollen rubber parts caused by incorrect or contaminated brake fluid, (b) plugged master cylinder compensating ports

   Corrective action(s): (a) replace all rubber parts; flush hydraulic system and fill with approved brake fluid, (b) repair or replace master cylinder

6. Possible cause(s): (a) loose wheel bearings

   Corrective action(s): (a) inspect and adjust bearings

7. Possible cause(s): (a) overheating, (b) lubricant failure, (c) overload

   Corrective action(s): (a), (b), and/or (c) replace bearing, check seals, and check for proper lubrication

8. Possible cause(s): (a) abrasive material or inefficient lubrication

   Corrective action(s): (a) check seals and replace bearings

9. Possible cause(s): (a) improper fit, cocking, or poor bearing seats

   Corrective action(s): replace bearing

10. Possible cause(s): inadequate lubrication

    Corrective action(s): replace bearing, clean related parts, check seals, check for proper lubrication

ASSIGNMENT SHEET 2

1. c
2. b
3. c
4. a
5. c
6. a
7. b
8. b
9. a
10. a
11. c
12. b
13. a
14. c
15. a

JOB SHEET 1

Development of:
READING SKILLS
WRITING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, writing, and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  - Following written instructions
  - Interpreting graphics & symbols

  WRITING SKILLS

  - Completing forms and records

  EMPLOYABILITY SKILLS

  - Mastering a specific job task/procedure
  - Practicing good work habits/attitudes

- If students have difficulty following written instructions:
  - Discuss the possible consequences of not following instructions precisely.
  - Have them read the instructions several times, noting the key words and ideas.
  - Explain to students that illustrations are also part of the instructions. Encourage them to compare their work to that shown in photographs and drawings.
  - Discuss the difference between text guidelines and service manual instructions.
  - Have students restate the instructions in their own words.

- If students have difficulty completing forms and records:
  - Examine the structure of the forms being used.
  - Stress the importance of accurate, legible records.
- If students have difficulty practicing good work habits/attitudes:
  - Encourage them to become familiar with the entire procedure before they begin the work.
  - Discuss the role that good work habits and attitudes have in obtaining and retaining employment.
  - Discuss what behaviors and attitudes constitute good work habits.
  - Make sure the student knows what is expected of him or her.
- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1 and Assignment Sheet 1.

JOB SHEETS 2, 7 & 8

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

READING SKILLS

- Using standard references
- Following written instructions
- Interpreting graphics & symbols

EMPLOYABILITY SKILLS

- Mastering a specific job task/procedure

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- Practicing good work habits/attitudes

- If students have difficulty using standard references:
  - Locate and explain the purpose of the reference section of the library.
  - Discuss the fact that each standard reference provides a specific type of information.
  - Review each element of the service manual that might be used, including exploded illustrations, rotated illustrations, parts lists, allowable variance charts, and procedure instructions. Discuss the use for and importance of each element.
  - Review the use of alternative references, such as computer data bases and telephone help lines.
- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1, Assignment Sheet 1, and Job Sheet 1.

JOB SHEETS 3 & 13

Development of:
READING SKILLS
WRITING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, writing, and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  - Using standard references
  - Following written instructions
  - Interpreting graphics & symbols

  WRITING SKILLS

  - Completing forms and records

EMPLOYABILITY SKILLS

- — Mastering a specific job task/procedure
- — Practicing good work habits/attitudes

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1, Assignment Sheet 1, and Job Sheets 1 & 2.

JOB SHEET 4

Development of:
READING SKILLS
SCIENCE SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, science, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

READING SKILLS

- — Using standard references
- — Following written instructions
- — Interpreting graphics & symbols

SCIENCE SKILLS

- — Using scientific instruments (dial indicator)

EMPLOYABILITY SKILLS

- — Mastering a specific job task/procedure
- — Practicing good work habits/attitudes

- If students have difficulty using scientific instruments, review the correct procedure for their use.

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1, Assignment Sheet 1, and Job Sheets 1 & 2.

JOB SHEETS 5, 6, 10, & 17

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  - Using standard references
  - Following written instructions

  EMPLOYABILITY SKILLS

  - Mastering a specific job task/procedure

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1 and Job Sheets 1 & 2.

JOB SHEET 9

Development of:
READING SKILLS
ORAL COMMUNICATION SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, oral communication, and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  - Using standard references
  - Following written instructions
  - Interpreting graphics & symbols

ORAL COMMUNICATION SKILLS

- Communicating with co-workers

EMPLOYABILITY SKILLS

- Mastering a specific job task/procedure
- Practicing good work habits/attitudes

- If students have difficulty communicating or interacting with co-workers:
  - Explain the importance of teamwork.
  - Suggest that workers trade jobs in order to better understand how to assist one another.
  - Review listening skills, questioning techniques, giving/following directions, and non-verbal communication.
- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1 and Job Sheets 1 & 2.

JOB SHEETS 11 & 12

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

READING SKILLS

- Using standard references
- Following written instructions
- Interpreting graphics & symbols

EMPLOYABILITY SKILLS

- Mastering a specific job task/procedure

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- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1 and Job Sheets 1 & 2.

JOB SHEET 14

Development of:
READING SKILLS
WRITING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, writing, and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  - Gaining factual information
  - Using standard references
  - Following written instructions
  - Interpreting graphics & symbols

  WRITING SKILLS

  - Completing forms and records

  EMPLOYABILITY SKILLS

  - Mastering a specific job task/procedure
  - Practicing good work habits/attitudes

- If students have difficulty gaining factual information:
  - Suggest they read carefully, noting key words and ideas.
  - Instruct them to list the questions they hope to answer.
  - Have students practice identifying similar information presented orally or on video tape.
- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1 and Job Sheets 1 & 2.

JOB SHEET 15

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  - Using standard references
  - Following written instructions
  - Interpreting graphics & symbols
  - Using content area vocabulary

  EMPLOYABILITY SKILLS

  - Mastering a specific job task/procedure
  - Practicing good work habits/attitudes

- If students have difficulty using content area vocabulary, review key terms and concepts, so that students hear, see, write, and say them.
- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1, Assignment Sheet 1, and Job Sheets 1 & 2.

JOB SHEET 16

Development of:
READING SKILLS
WRITING SKILLS

- Introduce the assignment to the students by discussing why reading and writing skills are important.
- Discuss with them the following skills which are relevant to this task:

READING SKILLS

— Using standard references

— Following written instructions

— Interpreting graphics & symbols

WRITING SKILLS

— Completing forms and records

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1 and Job Sheets 1 & 2.

JOB SHEET 1

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 23

Inspect, test, and service hydraulic brake lines and hoses.

INTRODUCTION

Hydraulic lines and flexible hoses transmit fluid pressure from the master cylinder to the wheel cylinders and calipers. Even partial blockage of the lines restricts the flow of brake fluid and thus reduces the braking effectiveness of the vehicle. The Brakes Specialist knows the importance of thoroughly and carefully inspecting, testing, and properly servicing brake lines and hoses.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Brake System Inspection Report Form
- Approved brake fluid
- Replacement lines and hoses
- String
- Ruler
- Tubing bender
- Replacement copper washers
- Tubing wrench
- Open-end wrench
- Pliers
- Brake bleeding equipment
- Hydraulic lift or jack and jack stands

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Inspect lines and hoses

NOTE: Be sure to note all inspection findings on your Brake System Inspection Report Form.

1. Raise vehicle and support safely.

Functional Writing Skills

- Complete forms and records

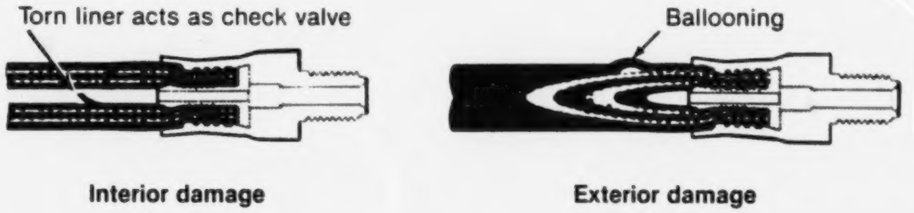
Job Acquisition/ Development Skills

- Master specific job task/procedure
- Practice good work habits/attitudes

2. Inspect steel lines and their fittings for:
   - stains that indicate a very minute loss of fluid;
   - excessive external rusting;
   - indentions or bruises caused by stones and other road objects.

3. Inspect flexible brake hoses for:
   - chafing caused by stress or unnecessary twist;
     NOTE: Hoses that have functioned under stress will often separate internally. Stress causes the inside lining of the hose to separate and restrict fluid flow, acting as a check valve and possibly producing a dragging brake. See Figure 1 below.
   - cracking, blistering, or fraying near metal fittings;
   - ballooning caused by separation and rupture of hose layers. (Figure 1)

FIGURE 1



From *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed., copyright 1985. Used with permission of Wagner Brake Company, Ltd.

4. Test hoses for internal damage by applying pressure to brake pedal and watching or feeling for any bulging or expansion of hose.

5. If visual inspection reveals that lines, hoses, and fittings are in good condition, test the brake system for line or hose problems that may still exist but may not be evident.

6. Park vehicle on level, unobstructed surface.

7. Protect front seat with seat cover.

8. If vehicle is equipped with power-assist unit, place transmission in NEUTRAL or PARK, and start engine.

   NOTE: If vehicle has no power-assist unit, perform this test with the engine off.

9. Firmly depress brake pedal; if pedal is spongy or if it suddenly sinks to floorboard, the hydraulic system needs repair.

10. If inspection reveals defective lines, hoses, or fittings, the faulty parts must be replaced.

    NOTE: After you have carefully inspected and tested the brake lines and hoses and have determined that a part of a line must be replaced, chances are that other sections of that hydraulic line are also defective. Brake safety experts and vehicle manufacturers strongly recommend that the Brakes Specialist replace the entire line, not just a section of it. Further, it is recommended that the specialist purchase ready-made steel lines whenever possible.

PROCEDURE

Job Acquisition/ Development Skills
- Master specific job task/procedure

Replace brake lines

1. Raise vehicle and support safely.
2. Study configuration of original line.
3. Clean all dirt from ends of tubing and from area around connections to avoid getting dirt into hydraulic system during reassembly.
4. Loosen fittings with correct-size tubing wrench or open-end wrench.
5. Disconnect line and allow fluid to drain into container if necessary

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

6. Properly plug open female connections.

   NOTE: Lines have male connections on both ends.

7. Remove old brake tubing, cutting it into smaller pieces as necessary.

8. Lay out tubing on floor and use a string to determine the total length of the entire line.

9. Select ISO or double flare replacement tubing of the correct length and diameter to meet vehicle manufacturer's specifications.

   CAUTION

   Never use copper tubing in a hydraulic brake system. It does not have the strength of steel tubing and can rupture under high brake pressure.

10. Use tubing bender to shape tubing to configuration of original line, taking care to avoid kinks and sharp bends.

11. Carefully blow out tubing with compressed air to remove any foreign matter.

12. Install new brake line on vehicle, using proper-size tubing wrench and tightening connections to manufacturer's specifications.

PROCEDURE

Job Acquisition/ Development Skills
- Master specific job task/procedure

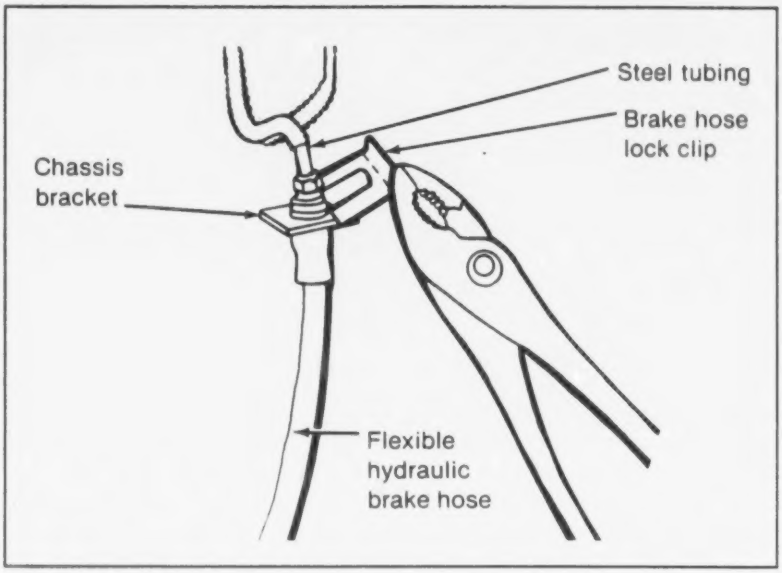
Replace brake hoses

1. Raise vehicle and support safely.

2. Clean all dirt from ends of hose to reduce the possibility of getting dirt in the system during reassembly.

3. Loosen jam nut, and disconnect female end of hose first, using pliers to remove lock clip. (Figure 2)

FIGURE 2


Steel tubing
Brake hose lock clip
Chassis bracket
Flexible hydraulic brake hose

4. Unscrew male end of hose.

5. Measure hose and examine fitting.

6. Select replacement hose with same end fittings and of same length of original (or slightly longer than original).

CAUTION

Use only hoses that meet safety standards as specified in vehicle service manual.

NOTE: Hose must be long enough to avoid tension or strain when the suspension springs are in the full-rebound position.

7. Screw a spare tube nut into the female fitting to avoid distortion.

8. Place new copper washer over male end of replacement hose, and connect male end first, tightening it to manufacturer's specifications.

9. Remove spare tube nut from female fitting.

10. Install female end of hose in position that turns curve of hose away from any point of chafing contact; tighten to manufacturer's specifications.

11. Install hose suspension spring or support if applicable.

12. Check for interference of hose with chassis, suspension, and body during chassis spring rebound and when wheels are steered to extreme left and right.

13. Eliminate any interference by loosening female end of hose, repositioning it, and retightening it to manufacturer's specifications.

CAUTION

Never twist a brake hose by tightening the male end after the female end has been installed. To avoid twisting the brake hose, hold the hose securely while installing it, and keep the reference line on the hose straight.

PROCEDURE

Job Acquisition/Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

Complete service

1. Flush hydraulic system to remove air and contaminated fluid.

2. Repeat inspection procedures to ensure that there are no leaks in system.

3. Lower vehicle to floor.

4. Road test vehicle.

◆ WARNING ◆

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

5. Clean work area and return equipment and materials to proper storage.

JOB SHEET 2 — SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

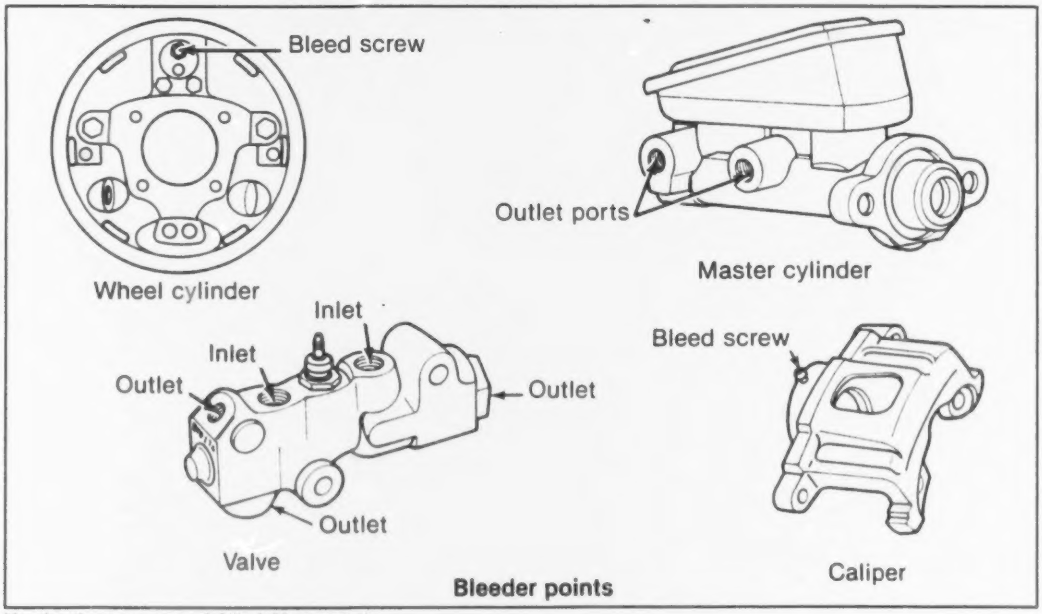
OBJECTIVE 24 **Bleed or flush a hydraulic braking system.**

INTRODUCTION

The brake hydraulic system must be free of air and contaminants to function properly. Air and contaminants may enter the system when any of the hydraulic parts are disconnected, or when the brakes are operated with the master cylinder fluid level very low. Any air in the system is compressed when pressure is applied, and the results are a springy, spongy brake pedal and ineffective braking action.

Depending on the point at which the hydraulic system was opened, bleeding may be required at all four wheels and the master cylinder, or bleeding may be required at only one location. If the system contains contaminated brake fluid or the wrong type of brake fluid, all old fluid must be flushed from the system and replaced with new. Use the following guidelines and the typical bleeder points illustrated in Figure 1 to aid you in knowing when and where to bleed the hydraulic braking system.

FIGURE 1



Bleeder points

Used with permission of Allied Aftermarket.

Guidelines:

- Bleed complete hydraulic system at all four wheels and master cylinder if lines were disconnected from master cylinder or if brakes were operated when master cylinder fluid level was low.
- Considering whether braking system is a front-to-rear split system or a diagonally split system, bleed hydraulic system at both wheels of affected system circuit if line serving set of wheels was disconnected at master cylinder or if brakes were used when master cylinder fluid level was low in reservoir serving that set of wheels.
- When bleeding brake system, always start at bleeder points farthest away from master cylinder.
- Flush entire system if brake fluid is contaminated or is the wrong type.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Transparent container
- Bleeder hoses (rubber or plastic tubing)
- Approved brake fluid
- Hydraulic lift or jack and jack stands
- Pressure bleeder and reservoir adapter
- Shop cloths
- Fender and seat covers
- Six-point box wrench or brake bleeder wrench
- Metering valve tool

CAUTION
Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Manually bleed a hydraulic system

NOTE: Follow vehicle manufacturer's instructions for bleeding a vehicle with a quick take-up master cylinder or a hydraulic power-assist unit.

Functional Reading Skills

- Follow written instructions
- Interpret graphics and symbols

Job Acquisition/ Development Skills

- Master specific job task/procedure
- Practice good work habits/attitudes

1. Remove switch terminal plug from brake warning light switch if applicable.

   NOTE: On some American Motors, International Harvester, and Kaiser-Jeep vehicles, the switch terminal will be damaged if the terminal plug is not removed before bleeding. Refer to the service manual.

2. Cover fenders and seats.

3. Fill master cylinder reservoirs to three-quarters full with clean, approved brake fluid; replace diaphragm and cover.

   CAUTION

   Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

   NOTE: Check the master cylinder fluid level often during the bleeding process. Be sure to keep the reservoirs at least half full to prevent air from entering the system and make sure that the cover and diaphragm are in position before the brakes are applied.

4. Raise vehicle and support safely.

5. Place six-point box wrench or brake bleeder wrench over bleeder screw recommended as first in sequence by service manual.

6. Fit tubing snugly over bleeder screw and submerge free end of tubing in brake fluid in transparent container.

7. Apply (or have helper apply) steady pressure on brake pedal.

8. Open bleeder screw until fluid flows freely.

   NOTE: The bleeder screw may have to be removed and cleaned before fluid will flow. If such is the case, plug the opening during the cleaning process.

9. When bleeder screw is opened, the brake pedal will move toward the floorboard; have helper depress pedal all the way.

CAUTION

Advise your helper not to work the brake pedal on and off or to apply great force. Internal damage to the master cylinder may result.

10. Close bleeder screw and instruct helper to release brake pedal.

11. Repeat steps 7 through 10 until fluid is completely free of air bubbles.

12. Remove tubing and brake bleeder wrench.

13. Check master cylinder reservoirs and refill with clean, approved brake fluid to at least three-quarters full if necessary.

14. Repeat bleeding procedure for other bleeding locations as recommended by service manual.

15. Check brake pedal to be sure that it is high and firm; if it feels spongy, repeat manual bleeding procedure.

16. Reinstall brake warning light switch terminal plug.

17. Center pressure differential valve if necessary.

    NOTE: Bleeding the front brakes creates an imbalance in the hydraulic pressure between the front and rear braking systems. This pressure difference will cause the brake warning light to come on. Centering the pressure differential valve equalizes the pressure and turns off the brake warning light.

18. With transmission in PARK or NEUTRAL and engine running, depress brake pedal.

    NOTE: The pressure differential valve piston should center itself, turning off the brake warning light. If the light remains on, the switch is not self-centering, and you must relieve pressure in the rear braking system by performing the following steps.

19. Remove switch terminal plug from brake warning light switch.

20. Have helper hold brake pedal firmly at floorboard.

21. Install brake bleeder wrench and tubing over either rear wheel cylinder bleeder screw and submerge free end of tubing in brake fluid as shown in Figure 2.

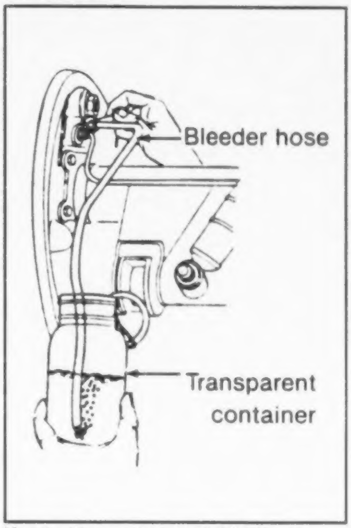
22. Quickly open and close bleeder screw.

23. Reinstall brake warning light switch terminal plug.

24. Lower vehicle to floor.

25. Road test vehicle.

FIGURE 2



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♦ WARNING ♦

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

26. Clean work area and return equipment and materials to proper storage.

PROCEDURE

Job Acquisition/ Development Skills

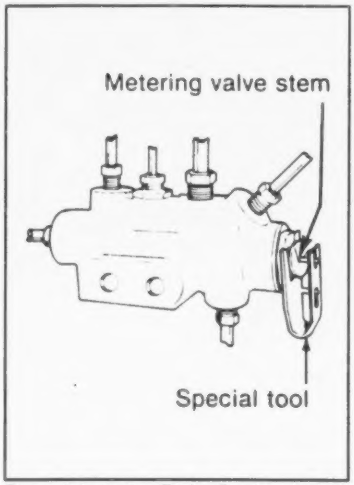
- Master specific job task/procedure
- Practice good work habits/attitudes

Pressure bleed a hydraulic system

NOTE: Follow vehicle manufacturer's instructions for bleeding vehicles with a quick take-up master cylinder, or hydraulic power-assist unit.

1. Perform steps 1 through 3 of the manual bleeding procedure.
2. If vehicle's brake system is equipped with a metering valve (part of the combination valve), attach metering valve tool to hold valve open as shown in Figure 3.
3. Check pressure bleeder tank to be sure that there is enough brake fluid to complete bleeding operation; fill if necessary.
4. Charge tank to pressure specified by pressure bleeder manufacturer.
5. Attach appropriate reservoir adapter to master cylinder, consulting service manual for installation procedures.

FIGURE 3



From *Automotive Brake Service, Unit 2: Front Disc Brake Service*, © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

NOTE: Different vehicles require different sizes and types of bleeder adapters, and the methods of attaching these adapters will vary.

6. Open valve in pressure bleeder hose to pressurize tank.
7. Raise vehicle carefully and support safely, taking care not to damage bleeding equipment.
8. Place six-point box wrench or brake bleeder wrench over bleeder screw recommended as first in sequence by service manual.
9. Fit tubing snugly over bleeder screw and submerge free end of tubing in brake fluid in transparent container.

10. Open bleeder screw until fluid flows freely.

    NOTE: The bleeder screw may have to be removed and cleaned before fluid will flow. If such is the case, plug the opening during the cleaning process.

11. When fluid coming from end of submerged tubing is completely free of air bubbles, close bleeder screw securely and remove wrench.

12. Repeat steps 8 through 11 for other bleeding locations as recommended in service manual.

13. Check master cylinder fluid level and refill with clean, approved brake fluid to at least three-quarters full if necessary.

    CAUTION

    Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

14. Check brake pedal to be sure that it is high and firm; if it feels spongy, repeat pressure bleeding procedure.

15. Reinstall brake warning light switch terminal plug.

16. Center pressure differential valve if necessary, following instructions under step 17 of manual bleeding procedure.

17. Lower vehicle to floor.

18. Road test vehicle.

    ♦ WARNING ♦

    Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

19. Clean work area and return equipment and materials to proper storage.

PROCEDURE

Job Acquisition/
Development Skills
- Master specific job task/procedure

Surge bleed a hydraulic system

NOTE: If manual or pressure bleeding procedures failed to remove all air from the system, the system should be surge bled. Surge bleeding includes both manual and pressure bleeding and deliberately creates a churning, higher pressure turbulence so that any trapped air can be drawn off. It is important to remove all possible air before surging, thus this method is never used unless manual or pressure bleeding has proved inadequate.

1. Pressure bleed or manually bleed hydraulic system at all four wheels in the usual manner.
2. Have helper depress brake pedal sharply several times while you open and close bleeder screw at each wheel cylinder in turn.

   NOTE: This action creates turbulence in each cylinder, forcing out trapped air.
3. Check master cylinder fluid level; refill with approved, clean brake fluid to three-quarters full if necessary.

   CAUTION

   Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.
4. Check brake pedal to be sure that it is high and firm; if it feels spongy, repeat surging procedure.
5. Reinstall brake warning light switch terminal plug.
6. Center pressure differential valve if necessary, following instructions under step 17 of manual bleeding procedure.
7. Lower vehicle to floor.

8. Road test vehicle.

◆ WARNING ◆

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

9. Clean work area and return equipment and materials to proper storage.

JOB SHEET 3

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 25

Remove, clean, inspect, and repack (or replace and pack) wheel bearings and replace seals.

INTRODUCTION

Dirt is the most common cause of wheel bearing failure. Most vehicle manufacturers recommend that bearings be serviced and lubricated at intervals of 25,000 to 30,000 miles.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Wheel cover removing tool
- C-clamp
- Hydraulic lift or jack and jack stands
- EPA-approved asbestos safety equipment and recommended protective clothing
- Fender and seat covers
- Syringe
- Low-pressure air nozzle
- Dust cap removing tool
- Seal driver
- Dial indicator
- Torque wrench
- Wooden dowel
- Wheel bearing packer
- Clean shop towels
- Parts-cleaning brush
- Wood blocks
- Appropriate wheel bearing grease
- Approved cleaning solvent
- Approved brake fluid
- Replacement grease seals
- Diagonal pliers
- Small chain or wire
- Chalk or marker
- Rubber-tipped hammer
- Screwdriver or brake adjusting spoon
- Open-end wrench
- Replacement parts as necessary
- Brake System Inspection Report Form

◆ WARNING ◆

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Functional Writing Skills
- Complete forms and records

Job Acquisition/ Development Skills
- Practice good work habits/attitudes

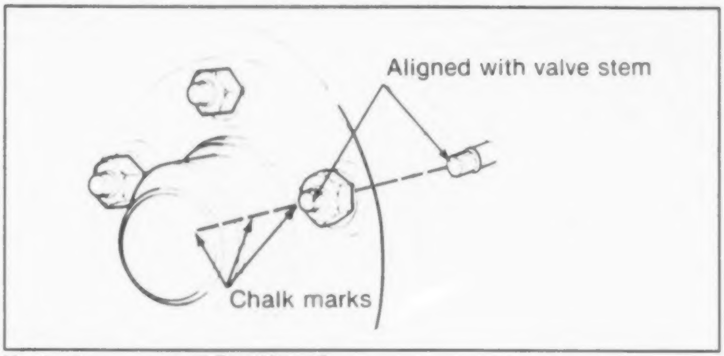
1. Cover fenders and seats.
2. Use syringe to remove about two-thirds of brake fluid from master cylinder reservoir supplying front or rear wheels, depending on bearings to be serviced.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Keep brake fluid away from fire; brake fluid is flammable.

3. Raise vehicle and support safely.
4. To ensure that balanced wheels are reinstalled in same position, mark with chalk or marker each wheel to be removed as shown in Figure 1.

FIGURE 1



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5. Remove front or rear wheels, depending on bearings to be serviced.

PROCEDURE

Job Acquisition/Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

Remove front disc brake bearing assemblies.

1. Use C-clamp to compress each caliper piston to bottom of its bore. (Figure 2)

2. Remove each front caliper from its position over rotor, and hang from frame or suspension member with chain or wire as shown in Figure 3 on the next page.

FIGURE 2

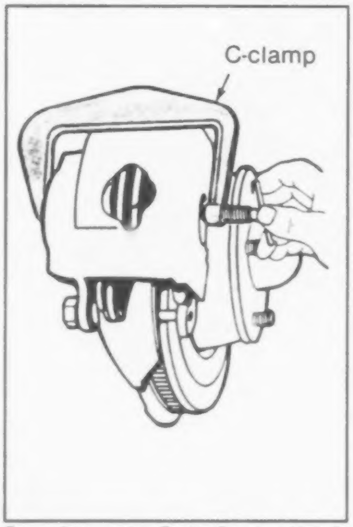

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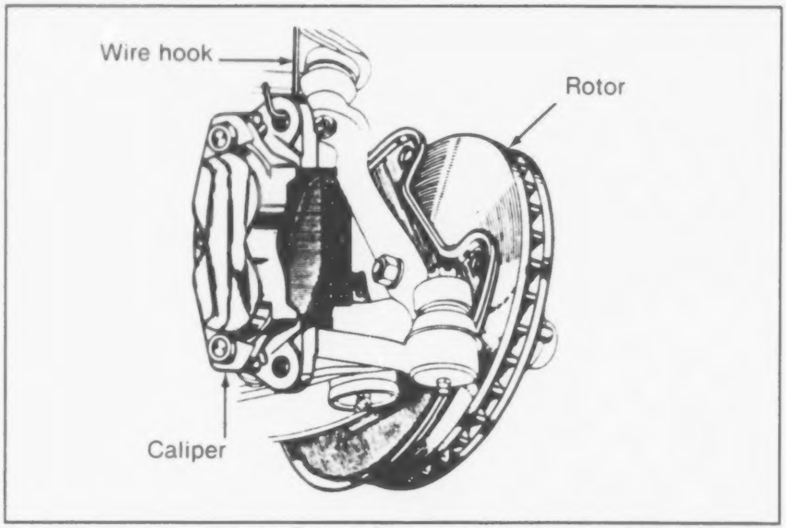
FIGURE 3



Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

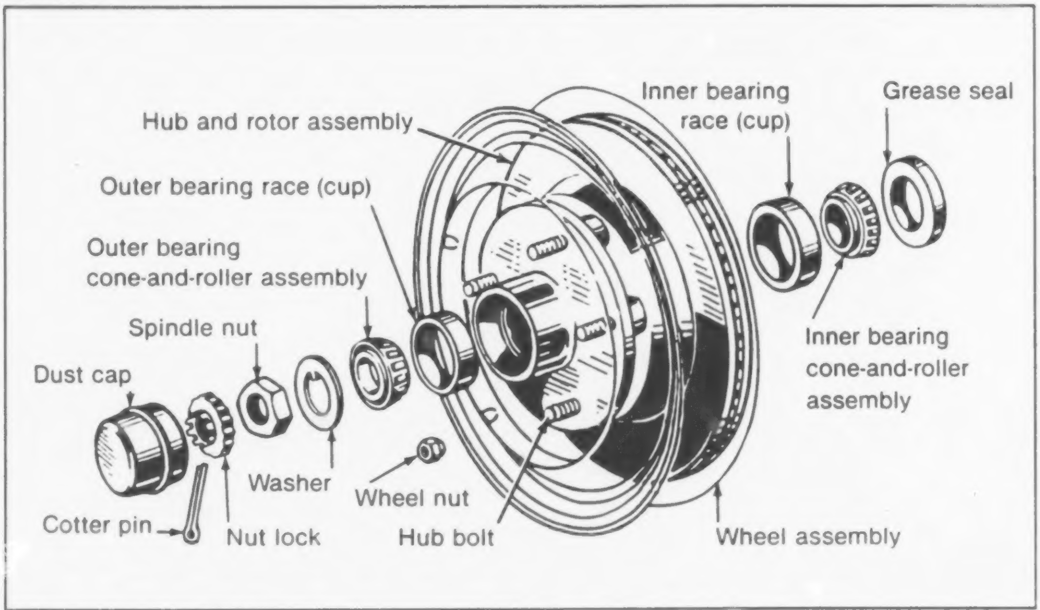
3. Remove dust cap with dust cap removing tool. (Figure 4)

NOTE: If dust cap removing tool is not available, the dust cap can be carefully removed with channel-lock pliers.

CAUTION

Whichever tool you use, avoid damaging the dust cap. If bent, the cap may not seal properly, allowing moisture and dirt to enter the hub and damage the bearings.

FIGURE 4


Inner bearing race (cup)
Grease seal
Hub and rotor assembly
Outer bearing race (cup)
Outer bearing cone-and-roller assembly
Spindle nut
Dust cap
Inner bearing cone-and-roller assembly
Washer
Wheel nut
Cotter pin
Nut lock
Hub bolt
Wheel assembly

Used with permission of Ford Motor Co.

4. Using diagonal pliers, straighten ends of cotter pin, pry it out of hole in spindle, and discard pin.

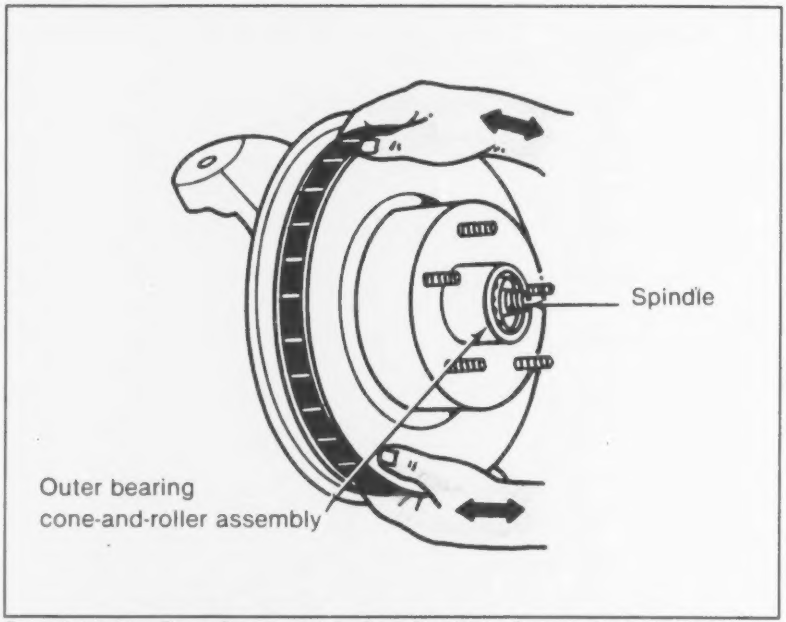
5. Use your fingers to remove nut lock if vehicle is so equipped.

6. Remove spindle nut with open-end wrench.

7. Remove washer from spindle and then slide outer bearing cone-and-roller assembly off spindle.

   NOTE: You may have to rock the rotor back and forth as shown in Figure 5. Rocking the rotor slides the outer cone-and-roller assembly out on the spindle to a position that enables you to grasp it with your fingers.

FIGURE 5



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CAUTION

Always keep the cone-and-roller assemblies in the correct position for the rotor from which you remove them. Because each assembly sets up a wear pattern in its race, the assembly and race are a matched set. Keep each set with its own pieces; do not mix them, and do not reinstall them on the opposite spindle.

8. Place outer cone-and-roller assembly on a clean cloth or a piece of paper.

9. Grasp rotor with both hands and pull it off spindle, taking care not to scrape rotor against spindle, as this could damage spindle threads.

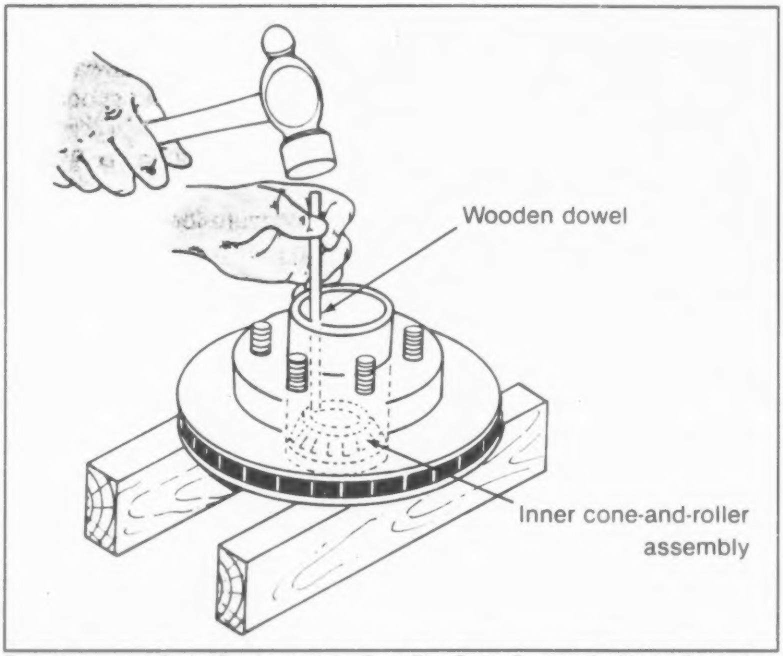
10. Place rotor on a clean area of your workbench, with outside of rotor facing up.

11. Repeat procedure for other front disc brake rotor.

12. Remove inner wheel bearing cone-and-roller assemblies and grease seals from rotors.

13. Raise rotor on wood blocks as shown in Figure 6.

FIGURE 6



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14. Remove inner cone-and-roller assembly from hub by gently tapping wooden dowel with hammer while moving dowel around edge of inner cone until grease seal and inner cone-and-roller assembly fall out.

15. Remove inner cone-and-roller assembly and grease seal from other disc brake rotor assembly.

PROCEDURE

Job Acquisition/ Development Skills
- Master specific job task/procedure

Remove drum brake bearing assemblies (front-wheel drive)

1. Release parking brake from inside vehicle.

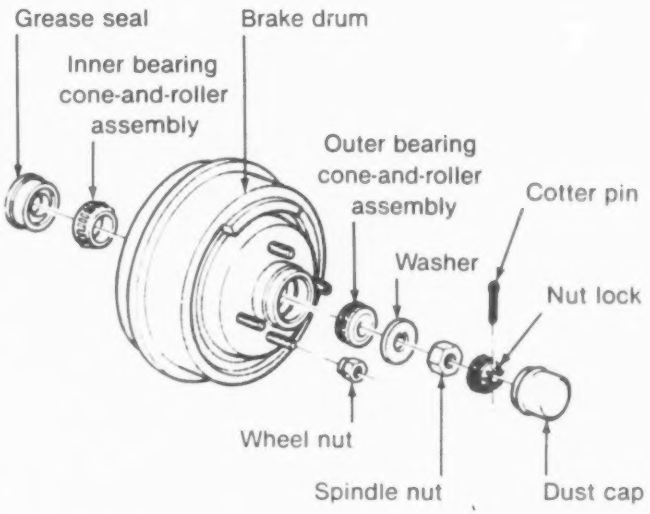
2. Loosen parking brake cable as required by backing off adjusting nut at equalizer.

3. If more clearance is needed, remove plug from support plate and rotate star wheel with an upward motion, using screwdriver or brake adjusting spoon.

4. Remove drum assembly. (Figure 7)

   NOTE: The procedure for removing drum brake assemblies on vehicles with rear-wheel drive may vary slightly. Consult your service manual.

FIGURE 7


Grease seal
Brake drum
Inner bearing cone-and-roller assembly
Outer bearing cone-and-roller assembly
Cotter pin
Washer
Nut lock
Wheel nut
Spindle nut
Dust cap

Used with permission of Chrysler Corp.

5. Remove dust cap with dust cap removing tool.

   NOTE: If a dust cap removing tool is not available, the dust cap can be carefully removed with channel-lock pliers.

CAUTION

Whichever tool you use, avoid damaging the dust cap. If bent, the cap may not seal properly, allowing moisture and dirt to enter the hub and damage the bearings.

6. Straighten end of cotter pin with diagonal pliers, pry it out of hole in spindle, and discard.

7. Use your fingers to remove nut lock.

8. Remove spindle nut with open-end wrench.

9. Remove washer from spindle and then slide outer bearing cone-and-roller assembly off spindle.

   NOTE: You may have to rock the brake drum back and forth to slide the outer bearing assembly to a position that enables you to grasp it with your fingers.

   CAUTION

   Always keep the bearing assemblies in the correct position for the drum from which you remove them. Because each assembly sets up a wear pattern in its race, the assembly and race are a matched set. Keep each set with its own pieces; do not mix them, and do not reinstall them on the opposite spindle.

10. Place outer bearing assembly on a clean cloth or piece of paper.

11. Grasp drum with both hands and carefully pull it off spindle, taking care not to scrape drum against spindle, as this could damage threads on end of spindle.

12. Place drum on a clean area of your workbench, with inside of drum facing up.

13. Repeat procedure for other drum brake.

14. Raise drum on wooden blocks as shown in Figure 6 for disc brakes.

15. Remove inner bearing assembly and grease seal from drum by gently tapping wooden dowel with hammer while moving dowel around edge of cone until bearing assembly and seal fall out.

16. Repeat procedure for other brake drum.

PROCEDURE

Job Acquisition/ Development Skills
- Master specific job task/procedure

Clean and inspect bearing assemblies

NOTE: Be sure to note all inspection findings on your Brake System Inspection Report Form.

1. Use a rag to wipe excess grease off each bearing assembly.

2. Soak each assembly in cleaning solvent, taking care not to mingle right and left sets.

♦ WARNING ♦

Always use solvent recommended by vehicle manufacturer. Never use gasoline or any other volatile liquid as a cleaning solvent. Such liquids are fire hazards and can be harmful to the skin and eyes.

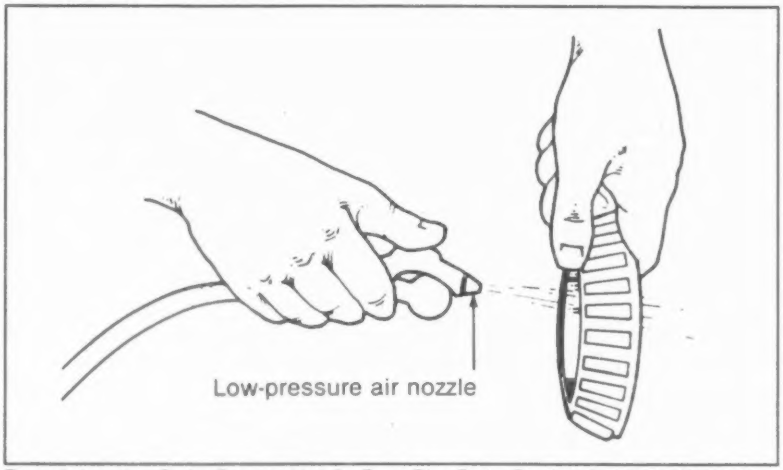
3. After they have soaked, scrub each assembly with parts-cleaning brush until assembly is clean.

4. Using low-pressure nozzle, blow out any remaining dirt particles and solvent from each assembly. (Figure 8)

CAUTION

Do not spin the rollers with compressed air. Spinning may damage the rollers or the inside race, or cause the assembly to fly apart with violent force.

FIGURE 8



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5. Using a rag and cleaning solvent, carefully clean grease and dirt from hub, races, and spindle so that they will not contaminate the clean bearing assemblies when they are installed later.

6. Visually inspect each bearing assembly for the following defects. (Refer to Supplement 5 as necessary.)

   - Cage damage or wear
   - Roller wear
   - Frettage
   - Brinelling
   - Etching
   - Indentations
   - Fatigue spalling
   - Galling

7. Place each cone-and-roller assembly into its original position in hub, and using your fingers, turn inner race to test each assembly in turn for roughness.

8. If you detect roughness, rinse and dry assembly again, and repeat rotation test with your fingers.

9. If you still detect roughness, replace defective wheel bearing assembly.

10. Wrap cone-and-roller assemblies in a clean shop towel or in paper to protect them from dust and dirt.

11. Visually inspect each bearing race for the following defects while it is still seated in the hub.

    - Hairline cracks
    - Pits or indentations
    - Heavy wear patterns
    - Hard spots (slightly flatter and very shiny areas)
    - Dark bluish heat discoloration
    - Light brown to black stain discoloration

12. If race is in good condition, coat it with a thin layer of wheel bearing grease and leave it in place; if it is defective, replace bearings and races as sets.

PROCEDURE

Job Acquisition/ Development Skills
- Master specific job task/procedure

Repack a bearing assembly with a bearing packer

NOTE: Even new bearing assemblies must be packed. Be sure to repack the assemblies with only the wheel bearing grease specified by the vehicle manufacturer. Read the container label or check the manufacturer's specified lubricant to be sure that you are using the proper grease.

1. Install bearing packer on bearing assembly, following packer manufacturer's directions.

2. Use packer to apply grease until all assembly cavities are filled.

3. Remove assembly from packer and apply a coat of grease to inner and outer edges of bearing cage.

4. Wrap packed assembly in a clean cloth or paper towel to protect fresh grease from dirt and dust; repeat packing procedure on each of other assemblies.

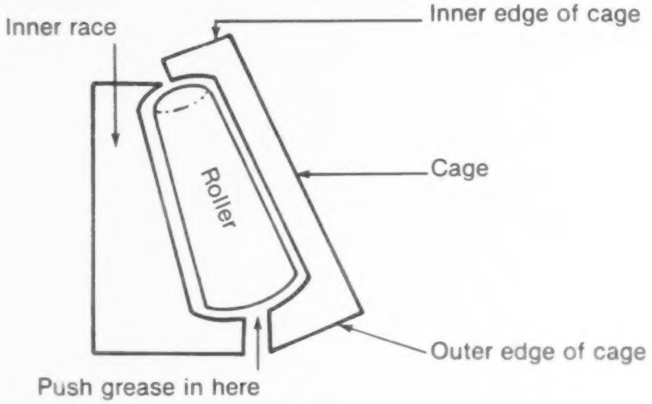
PROCEDURE

Job Acquisition/ Development Skills
- Master specific job task/procedure

Repack a bearing assembly by hand

1. Thoroughly work grease into bearing cage until all spaces between cage and rollers are filled, as shown in Figure 9.

FIGURE 9



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2. With your fingers, apply a thin coat of grease to inner and outer edges of the cage.

3. Wrap packed assembly in a clean cloth or paper towel to protect fresh grease from dirt and dust; repeat packing procedure on each of other assemblies.

PROCEDURE

Job Acquisition/ Development Skills
- Master specific job task/procedure

Reinstall packed cone-and-roller assemblies and grease seals

NOTE: After you repack all of the cone-and-roller assemblies and replace any defective parts, you must install the inner cone-and-roller assembly and a new grease seal in each hub.

1. Apply a thin coat of wheel bearing grease to inside of hub and bearing races.

2. Place packed inner cone-and-roller assembly into hub, with tapered end facing inward, toward hub recess.

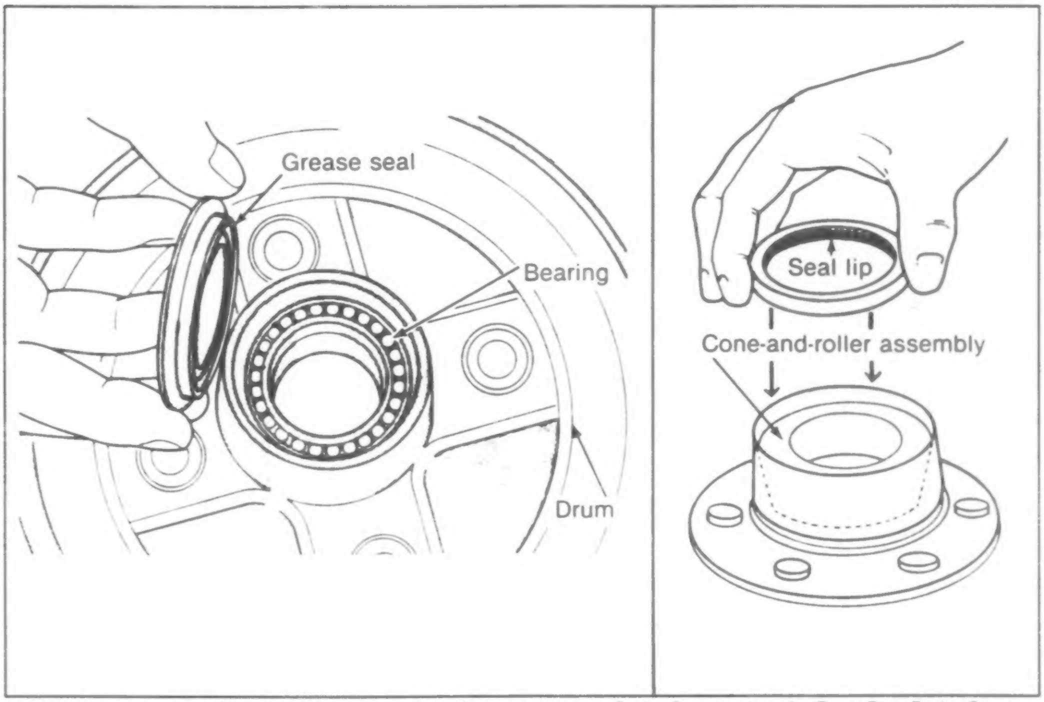
CAUTION

Be sure to replace the inner and outer cone-and-roller assemblies in their original positions on the left and right hub.

3. Inspect replacement grease seal for defects; if seal is in good condition, spread a thin coat of bearing grease around seal lip (inner surface of seal).

4. Position seal with its lip edge facing inward, toward the cone-and-roller assembly. (Figure 10)

FIGURE 10



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5. Install seal with seal driver, gently tapping driver with rubber-tipped hammer until seal is firmly in place.

CAUTION

Always tap gently when performing this procedure. Heavy blows will damage the seal.

6. Repeat procedure for other cone-and-roller assembly.

PROCEDURE

Job Acquisition/ Development Skills
- Master specific job task/procedure

Reinstall brake and wheel assemblies

1. Grasp rotor or drum with both hands and carefully slide it over spindle, taking care not to allow interior of drum or rotor hub to contact and damage threaded end of spindle.

   NOTE: As drum or rotor reaches the part of the spindle with the largest diameter, you will feel some resistance. Push the rotor or drum firmly past this point.

2. Insert outer cone-and-roller assembly into hub, with tapered end facing toward center of hub.

3. Place washer and then spindle nut on spindle.

4. Torque spindle nut to manufacturer's specifications while turning wheel assembly forward by hand to seat the bearings.

   NOTE: In addition to seating the bearings, turning the wheel assembly by hand removes any grease or burrs that could cause wheel-bearing play later.

5. Back off spindle nut until it is just barely loose.

6. Retorque spindle nut to manufacturer's specifications.

   NOTE: Some manufacturers call for finger-tightening the spindle nut at this point rather than using a torque wrench. Follow directions in service manual for vehicle you are working on.

7. Attach a dial indicator to measure end play as shown in Figure 11.

8. Push drum or rotor assembly in and line up zero on indicator dial with pointer hand.

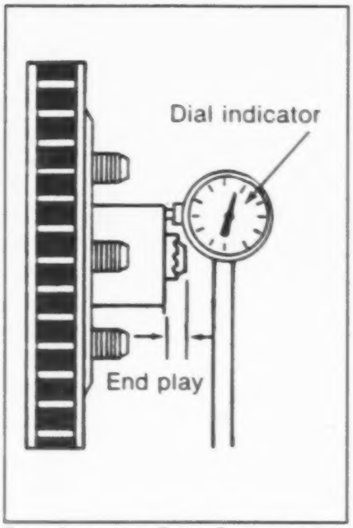
9. Pull hub out and note reading on dial indicator.

10. Adjust spindle nut until end-play reading is within specifications.

11. Retorque spindle nut to manufacturer's specifications.

12. Reinstall nut lock, if applicable, aligning it with cotter pin hole.

FIGURE 11



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CAUTION

Never move the spindle nut in order to align the nut lock with the spindle hole. This would make your final adjustment too loose or too tight. Once the spindle nut has been torqued to its final specifications, it is important not to move it.

13. Insert a new cotter pin through nut lock or castellated nut and through hole in spindle.

CAUTION

Always install a new cotter pin. Never reuse an old cotter pin as it has been weakened during removal and is unsafe.

14. Bend ends of cotter pin in opposite directions to secure it; cut off extra length to ensure that ends will not interfere with dust cap.

15. Clean dust cap with solvent.

16. Center dust cap on rotor hub.

17. Use rubber-tipped hammer to tap dust cap onto hub.

18. Readjust star wheel and parking brake cable on drum brakes or reinstall calipers and adjust parking brake cable on disc brakes.

19. Reinstall wheel/tire assemblies in their original positions, finger-tightening lug nuts.

20. Lower vehicle to floor.

21. Torque lug nuts in cross pattern to manufacturer's specifications.

22. Install wheel covers.

23. Bleed hydraulic system. (Job Sheet 2)

24. Check master cylinder fluid level and refill with clean, approved brake fluid to at least three-quarters full if necessary.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable. Keep brake fluid away from fire.

25. Reinstall master cylinder diaphragm and cover and secure with cover bails.

26. Road test vehicle.

♦ WARNING ♦

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

27. Clean work area and return equipment and materials to proper storage.

JOB SHEET 4

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 26

Adjust wheel bearings.

INTRODUCTION

Adjusting the wheel bearings is one of the most important parts of brake service. If wheel bearings are adjusted too tightly or too loosely, they will overheat or wear improperly and become damaged quickly. Loose wheel bearings can also cause rapid tire wear, uneven steering, and vibrations when braking.

Wheel bearings are normally adjusted (1) when they have been removed for routine cleaning, inspection, and repacking (approximately every 24,000 miles), (2) when brake or suspension work is being done and the drum or disc brake rotor must be removed as part of the work, and (3) when they do not meet manufacturer's specifications.

Always follow the vehicle manufacturer's specifications when adjusting wheel bearings. Improper adjustment can cause damage to the bearings and tires, as well as poor vehicle handling and braking vibrations.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Dial indicator
- Rubber mallet
- Hydraulic lift or jack and jack stands
- Replacement cotter pins
- Solvent for cleaning dust cap
- Diagonal-cutting pliers
- Hub cap remover
- Dust cap remover
- Torque wrench

◆ WARNING ◆

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

General Science Skills
- Use scientific instruments

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

1. Raise vehicle and support safely.
2. Remove wheel cover.
3. Remove dust cap from hub.

   CAUTION

   When removing the left-front dust cap, use care to avoid damage to the speedometer drive connection on some models.

4. Remove cotter pin from spindle and spindle nut.
5. Remove nut lock if vehicle is so equipped.

   NOTE: Most manufacturers today use a nut lock, which is a locking device that makes it possible to reinstall the cotter pin without moving the adjusted spindle nut.

6. Torque spindle nut to manufacturer's specifications while turning wheel assembly forward by hand to seat bearings.

   NOTE: In addition to seating the bearings, turning the wheel assembly by hand removes any grease or burrs that could cause wheel bearing play later.

7. Back off spindle nut until it is just barely loose.
8. Retorque spindle nut to manufacturer's specifications.

   NOTE: Some manufacturers call for finger-tightening the spindle nut at this point rather than using a torque wrench. Follow directions in service manual for vehicle you are working on.

9. To measure looseness (end play) in hub assembly, attach a dial indicator as shown in Figure 1

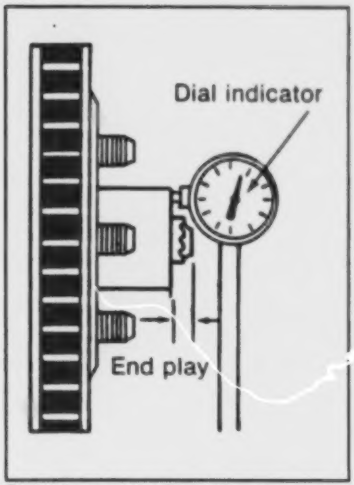
10. Push drum or rotor assembly in, and line up zero on indicator dial with pointer hand.

11. Pull hub out and note reading on indicator.

12. Adjust spindle nut until end play reading is within specifications.

13. Retorque spindle nut to manufacturer's specifications.

FIGURE 1



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14. Reinstall nut lock, if applicable, aligning it with cotter pin hole.

CAUTION

Never move the spindle nut in order to align the nut lock with the spindle hole. This would make your final adjustment too loose or too tight. Once the spindle nut has been torqued to final specifications, it is important not to move it.

15. Insert a new cotter pin through nut lock or castellated nut and through hole in spindle.

CAUTION

Always install a new cotter pin. Never reuse an old cotter pin as it has been weakened during removal and is unsafe.

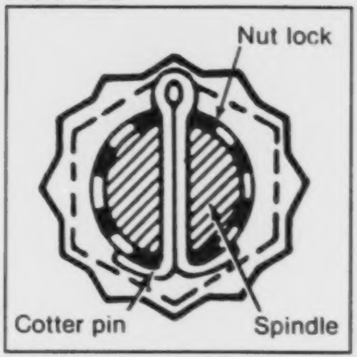
16. Bend ends of cotter pin in opposite directions to secure it; cut off extra length to ensure that the ends will not interfere with dust cap. (Figure 2)

17. Clean dust cap with solvent.

18. Center dust cap on rotor hub.

19. Use rubber mallet to tap dust cap onto hub.

FIGURE 2



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20. Replace wheel cover and perform adjustment procedure on other wheels.

21. Bleed hydraulic system. (Job Sheet 2)

22. Lower vehicle to floor.

23. Check master cylinder fluid level and refill with clean, approved brake fluid to at least three-quarters full if necessary.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable: keep brake fluid away from fire.

24. Reinstall master cylinder cover and diaphragm.

25. Road test vehicle.

CAUTION

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

26. Clean work area and return equipment and materials to proper storage.

JOB SHEET 5 — SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 27

Remove and replace front-wheel drive nonserviceable sealed wheel bearings.

INTRODUCTION

When the front-wheel bearings are sealed, nonadjustable units, they require no periodic attention. They are bolted to the steering knuckle by means of an integral flange. Service procedures requiring hub removal, however, may require that a new bearing be installed.

Because removal and installation procedures vary with make and model of vehicle, the Brakes Specialist should always consult the appropriate service manual for the proper procedure. Certain general precautions and guidelines should be observed, however, and these are listed below.

Guidelines:

- Follow all asbestos safety guidelines and use the latest in enclosure equipment for removal and replacement.
- After removal, discard the old hub nut and be sure to use a new nut and a new washer on assembly; do not use the old ones.
- Do not allow the caliper to hang from the brake hose; suspend it with a length of wire.
- If the old bearing is to be reused, match mark the bolts and holes for proper installation.
- If corrosion is present, make sure that the bearing is loose in the knuckle before pulling it out.
- Clean mating surfaces of all dirt and corrosion, and check knuckle bore and knuckle seal for damage.
- If a new bearing is to be installed, remove the knuckle seal and install a new one.
- If the rotor and hub start to rotate as the hub nut is tightened on reassembly, insert a long bolt through the cutout in the hub assembly to prevent rotation.

- Do not apply full torque to the hub nut until the wheel has been reinstalled and the vehicle lowered to the floor.
- When reinstalling the caliper, make sure that the caliper hose is not twisted.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 28 **Remove and replace a dual master cylinder.**

INTRODUCTION

Since 1967, all domestic vehicles have been designed with front and rear brake systems that utilize the dual (double-piston) master cylinder. Safety is the main advantage of the dual system over the single-piston master cylinder. In case of failure in one of the brake systems, the dual master cylinder system enables the system still operating to bring the vehicle to a safe, controlled stop.

Originally master cylinders were made of cast iron and were heavy. However, most master cylinders used in today's vehicles are composite master cylinders. Most use a plastic nylon reservoir in an aluminum housing. Composite master cylinders offer reduced weight and lower materials costs and have a greater application flexibility. Aluminum master cylinders also feature an anodized body to protect against corrosion and to extend bore life.

On the majority of today's vehicles, a power brake booster is attached to or is a part of the master cylinder. Because of this, the procedures for removing and reinstalling a master cylinder vary, and the Brakes Specialist should always consult the appropriate service manual for the proper procedure. Certain general precautions and guidelines should be observed, however, and these are listed below.

Guidelines:

- The two major defects indicating master cylinder replacement are internal seal failure and external leakage caused by a master cylinder with excessive scoring or pitting.
- Leakage at the reservoir cover can often be corrected by replacing the diaphragm and bending the cover bails to fit more securely.
- Leakage at the rear of the master cylinder indicates that the rear primary piston seal is leaking.

- Carefully inspect master cylinder bore for any scoring, pitting, or scratches. Light scoring in a cast-iron master cylinder can be cleaned with crocus cloth or honed. Aluminum master cylinders should not be reconditioned. If the cylinder bore is scored, pitted, or scratched, replace the complete master cylinder assembly.

- Discard and replace all rubber parts.

- Before assembling a master cylinder, dip each of its components in clean brake fluid and place them on a clean shop towel. Assembling a master cylinder with dry seals can ruin them.

- To ensure their sealing qualities, make sure that the cup lips enter the bore evenly.

- Adjust brake pedal free play after master cylinder installation.

- After installation, test to be sure that the master cylinder vents at both ports. Apply the pedal lightly with the engine running and observe the ports to see whether a geyser of fluid squirts up in the reservoirs. A fluid geyser indicates that the vent port is open.

- Bleed the brakes after installation, and check to see that the brake warning light is off. If the warning light is on, the master cylinder may be defective.

Safety guidelines:

- Raise vehicle and support safely.

- Know and observe all asbestos safety rules.

- Before road testing the vehicle, make sure that there is adequate fluid in the master cylinder and that the brake pedal is firm and high. Make a series of low-speed stops to be sure that the brakes are safe for road testing.

- Handle brake fluid carefully and do not use near heat or fire. Brake fluid is flammable. Take care also not to spill brake fluid on any painted or chrome surface as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

JOB SHEET 7 — SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

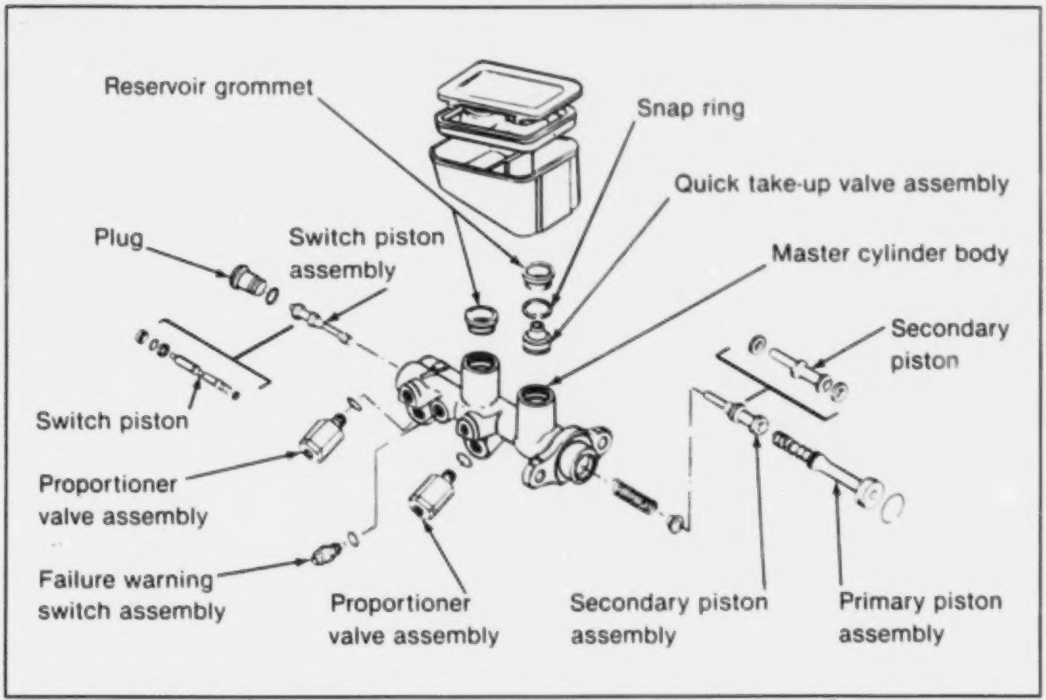
OBJECTIVE 29

Remove and replace a take-up valve in a quick take-up master cylinder.

INTRODUCTION

Quick take-up master cylinders may give rise to a problem unique to them. Imagine that you have bled the brakes and have expelled all air from the brake system. The brake shoes and pads are operating correctly, but the brake pedal is still very low. The cause of this problem may very well be a defective take-up valve inside the master cylinder. See Figure 1. This valve can be removed and replaced on many vehicles.

FIGURE 1


Reservoir grommet
Snap ring
Quick take-up valve assembly
Plug
Switch piston assembly
Master cylinder body
Secondary piston
Switch piston
Proportioner valve assembly
Failure warning switch assembly
Proportioner valve assembly
Secondary piston assembly
Primary piston assembly

Used with permission of Allied Aftermarket.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Set of flare-nut or tubing wrenches
- Flat-blade screwdriver

- Socket set
- Pliers
- Rubber-tipped hammer
- Fender and seat covers
- Replacement take-up valve
- Brake fluid
- Snap-ring pliers

CAUTION
Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

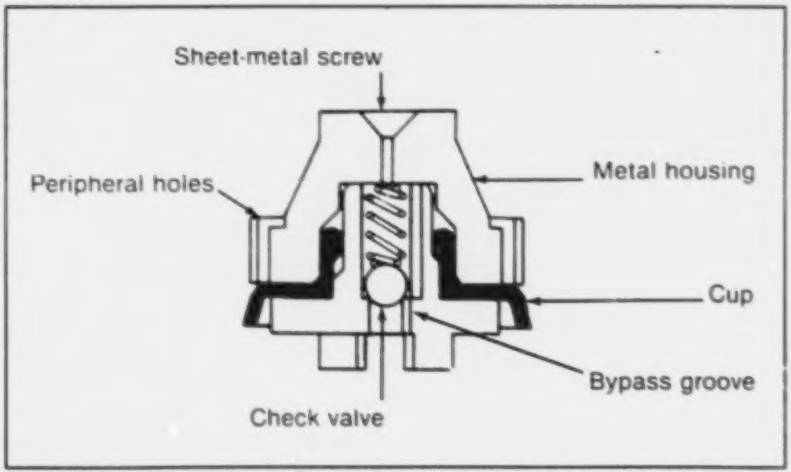
Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

1. Cover fenders and seats.
2. Remove reservoir from top of master cylinder and set reservoir aside where it will not get damaged or lost.
3. Remove reservoir grommet. (Figure 1)
4. Remove snap ring that retains take-up valve inside metal housing of master cylinder. (Figure 1)
5. Remove sheet-metal screw from valve center, if applicable. (Figure 2)

FIGURE 2



Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

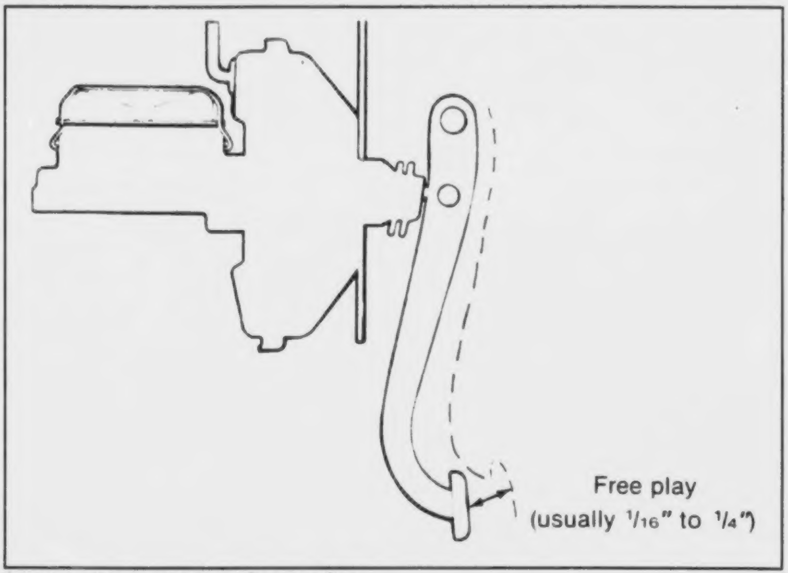
6. Use pliers to extract valve assembly from metal housing (Figure 2); discard valve assembly in appropriate receptacle.
7. Position valve assembly on metal housing. (Figure 1)
8. Place an appropriate-sized socket on top of valve assembly.
9. Install valve in housing by tapping firmly on socket with rubber-tipped hammer.
10. Reinstall sheet-metal screw in center of take-up valve, if applicable.
11. Reinstall retaining snap ring and reservoir grommet. (Figure 1)
12. Reinstall reservoir on top of master cylinder.
13. Fill reservoir three-quarters full with clean, approved brake fluid.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

14. Position reservoir diaphragm and cover over reservoir; snap cover bails firmly into place.
15. Measure pedal free play at pedal pad. (Figure 3)

FIGURE 3



Adapted with permission of Chrysler Corp.

16. Adjust pedal to manufacturer's specifications at master cylinder or at power brake pushrod by increasing or decreasing overall length of rod or by repositioning rod in relation to pedal arm.

    NOTE: Some rods have a clevis and locknut threaded on the rod while others have a rod eye and are adjusted by rotating an eccentric bolt that attaches the eye to the pedal arm. Refer to service manual.

17. Bleed hydraulic system. (Job Sheet 2)

18. Recheck fluid in master cylinder; refill with clean, approved brake fluid to at least three-quarters full if necessary.

    CAUTION

    Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

19. Road test vehicle.

◆ WARNING ◆

Before road testing any vehicle, check fluid level in master cylinder, and depress brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that brakes are safe for road testing.

20. Clean work area and return equipment and materials to proper storage.

JOB SHEET 8

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

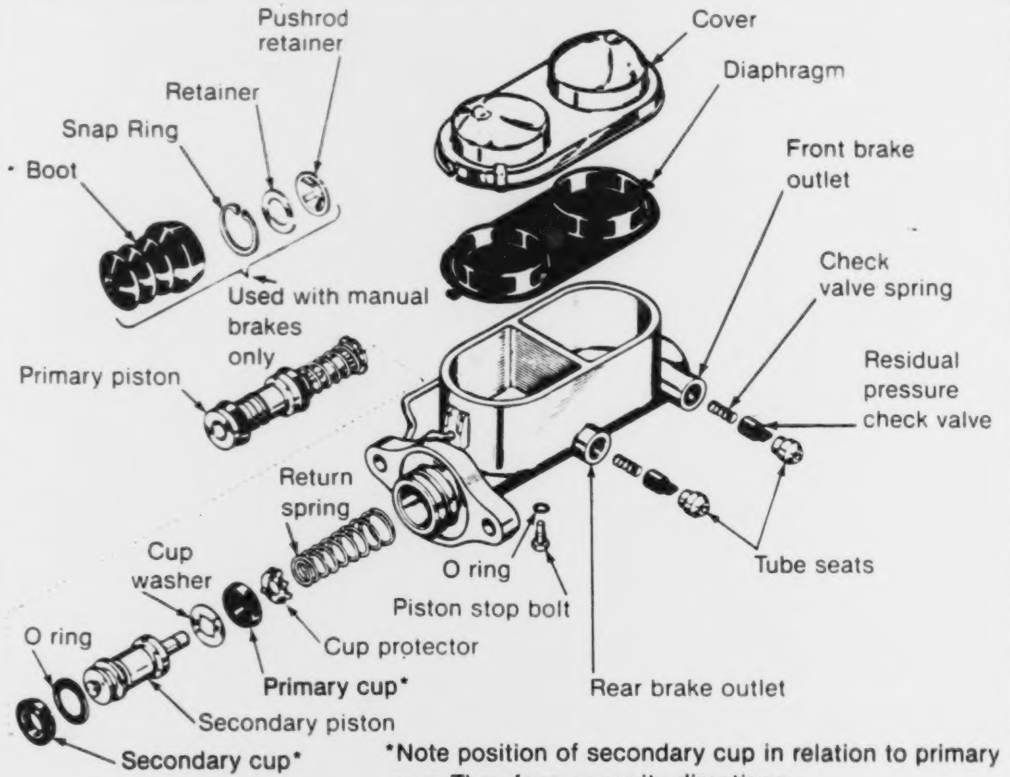
I

OBJECTIVE 30 **Overhaul a master cylinder.**

INTRODUCTION

There are many design and construction differences in the master cylinders built by various manufacturers. Because those differences require different procedures for assembly and disassembly, you should always consult the service manual about the particular master cylinder you are overhauling. A typical master cylinder is illustrated below in Figure 1. The residual pressure check valve is used only with drum brake systems. It is never used with disc brake systems. However, some newer-model vehicles with drum brakes do not use the residual pressure check valve, rather using an expander cup in the wheel cylinders. The following steps give the procedure for overhauling the typical master cylinder shown in Figure 1.

FIGURE 1


Pushrod retainer
Retainer
Snap Ring
Boot
Used with manual brakes only
Primary piston
Cover
Diaphragm
Front brake outlet
Check valve spring
Residual pressure check valve
Return spring
Cup washer
O ring
Piston stop bolt
Tube seats
O ring
Cup protector
Primary cup*
Rear brake outlet
Secondary piston
Secondary cup*

*Note position of secondary cup in relation to primary cup. They face opposite directions.

Adapted with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Fender and seat covers.
- Snap-ring pliers
- Screwdriver
- Brake bleeding equipment
- Diagonal side-cutting pliers
- Replacement check valve, tube seats, cups, and seals as necessary
- ¼-inch-wide feeler shim
- Syringe
- Plugs for outlets and hydraulic lines
- Tubing or flare-nut wrenches
- Approved brake fluid
- Brake cylinder hone
- Crocus cloth
- Approved parts-cleaning fluid
- Bench vise
- Torque wrench
- Lint-free shop towels
- Self-tapping screw, 6-32 × ⅝″

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

1. Cover fenders and seats.
2. Remove master cylinder from vehicle, following instructions in service manual.
3. Wipe or brush off external dirt from master cylinder.
4. Remove the reservoir cover and diaphragm from the master cylinder.
5. Use syringe to empty brake fluid from reservoirs.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

Job Acquisition/ Development Skills

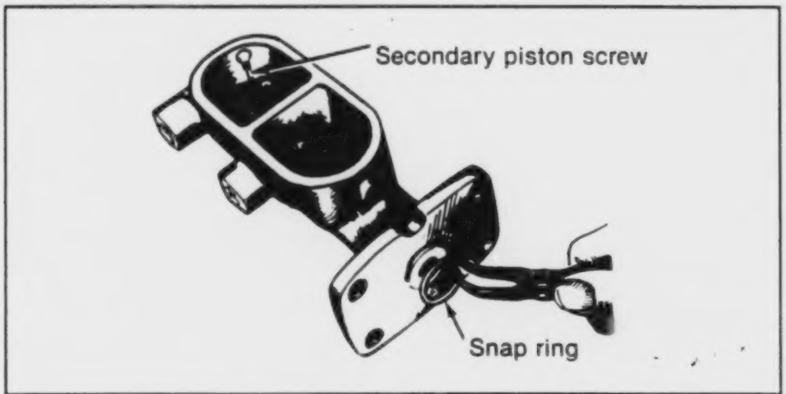
- Master specific job task/procedure
- Practice good work habits/attitudes

6. Mount master cylinder in vise, taking care not to apply excessive pressure to the casting.

7. Remove secondary piston screw. (Figure 2)

8. Remove primary piston snap ring and retainer. (Figure 2)

FIGURE 2



9. Remove primary piston assembly.

10. Remove secondary piston by tamping open end of master cylinder on bench or by using air pressure to force piston out of cylinder.

CAUTION

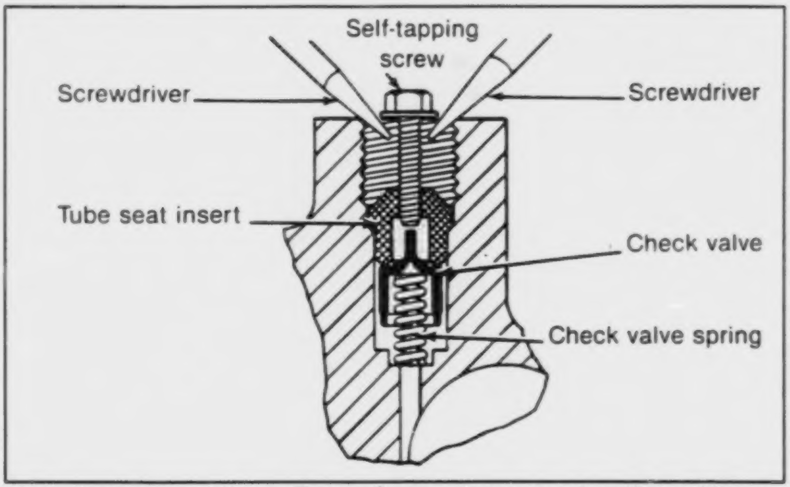
If using air pressure to remove the piston, place the open end of the cylinder against the bench.

11. Remove tube seats only if defective and replacement is recommended by manufacturer.

12. Thread 6-32 × ⅝-inch self-tapping screw into defective tube seat.

13. Place ends of two screwdrivers under head of screw as shown in Figure 3; pry screw upward to pull tube seat from its bore.

FIGURE 3



Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

14. Remove check valve and check valve spring if equipped.

15. Clean cylinder and parts to be reinstalled with approved cleaning fluid, using only lint-free wiping cloths, as lint can become trapped in bypass port passages and eventually plug them.

16. Clean minor scratches or signs of rust, corrosion, or discoloration from cylinder walls with crocus cloth, moving cloth in a circular rather than lengthwise direction.

17. Inspect cylinder bore for scoring and pitting.

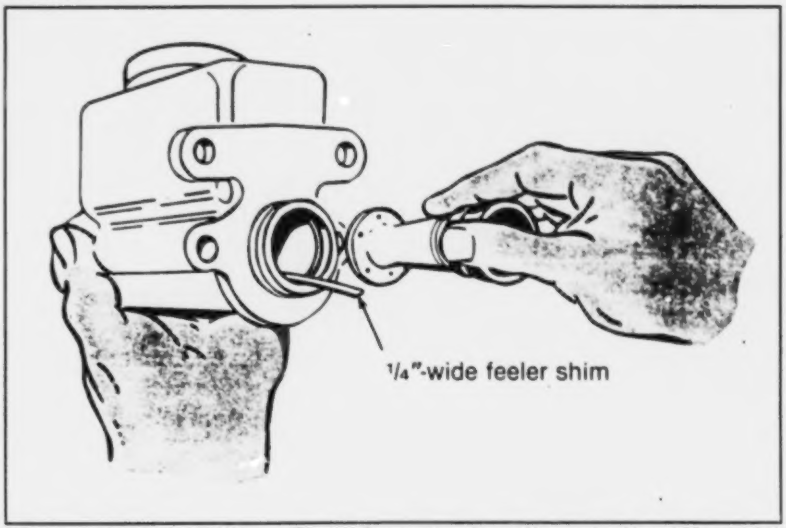
18. Hone cylinder if necessary, taking care not to increase diameter more than 0.002 inch.

    NOTE: If more honing is required, the master cylinder should be replaced rather than reconditioned.

19. Remove any burrs formed on edge of intake or bypass ports.

20. Check cylinder for excessive piston clearance by placing a ¼-inch-wide strip of feeler shim lengthwise in cylinder bore as shown in Figure 4; if piston can be inserted with shim in place, the cylinder is oversized and should be discarded.

FIGURE 4



Used with permission of Wagner Electric Corporation, from *Wagner Lockheed Manual AU-1600/July, 1970.*

21. Inspect pistons for scoring and corrosion; replace as necessary.

    NOTE: All cups and seals are replaced when reconditioning a master cylinder.

22. Dip each internal part in clean brake fluid just before reassembly.

23. Assemble new cups and seals on secondary piston, depressing cup lips with small, blunt probe to avoid nicking cup sealing edges.

    NOTE: The cup lip at the rear of the secondary piston must face the open (rear) end; all other cup lips face forward.

24. Install secondary piston return spring and secondary piston into cylinder.

25. Holding primary piston in seated position, install piston retainer and snap ring, making sure that it is fully seated in its locking groove.

26. Install secondary piston stop screw.

27. Install residual check valve and spring if equipped.

28. Install new tube seats if replacement is recommended by manufacturer.

    NOTE: The tube seats should not be removed or replaced unless they are damaged. Some manufacturers do not consider tube seat replacement to be a service operation. They recommend that the master cylinder be replaced if a tube seat is damaged. Use the following procedure only if tube seat replacement is recommended by the manufacturer.

29. Clean tube seat bore in outlet hole.

30. Position new tube seat in outlet hole, making sure that it is not cocked.

31. Using brake line nut as a press, turn nut down into outlet hole until tube seat bottoms in its bore.

32. Remove tubing nut and inspect tube seat for any burrs that may have been formed; remove burrs if found.

33. Bench bleed master cylinder. (Job Sheet 9)

34. Reinstall master cylinder, following instructions in service manual.

35. Bleed brake hydraulic system. (Job Sheet 2)

36. Check master cylinder piston end play be pumping brake pedal rapidly several times, and then hold firm pressure on pedal.

37. Release pressure on pedal while observing (or having a helper observe) master cylinder reservoirs for fluid creating a geyser while escaping from compensating port.

    NOTE: If fluid movement is not detected in the reservoirs, the master cylinder pistons are not returning to their seats properly. This problem must be corrected before the brakes will operate properly.

38. Check master cylinder fluid level, and fill with clean, approved brake fluid to at least three-quarters full if necessary.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

39. Reinstall reservoir diaphragm and cover, sealing securely with bails.

40. Road test vehicle to test for proper brake operation.

◆ WARNING ◆

Before test driving any vehicle, check fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

41. Check for fluid leaks after road test.

42. Clean work area and return equipment and materials to proper storage.

JOB SHEET 9

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 31

Bench bleed a master cylinder.

INTRODUCTION

Bench bleeding dual master cylinders before installation saves time and money. In order to expel all air trapped in the cylinder, dual master cylinders must be bench bled before they are installed on the vehicle. Bench bleeding reduces the possibility of air getting into the brake lines.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Bench vise
- Bench bleeding kit

NOTE: Bench bleeding kits are available that contain an assortment of fittings and tubing that will handle most domestic vehicles.

- Fender and seat covers
- Flare-nut or tubing wrench set
- Approved brake fluid
- Wooden dowel or smooth round-tipped rod

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

1. Mount master cylinder in vise, making sure that bore is horizontal, as shown in Figure 1.

CAUTION

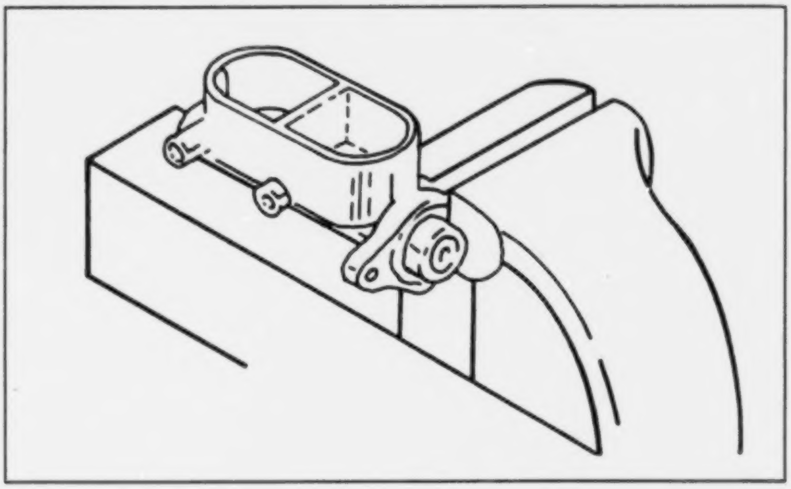
Do not apply excessive pressure to the casting.

- Interpret graphics and symbols

Job Acquisition/ Development Skills

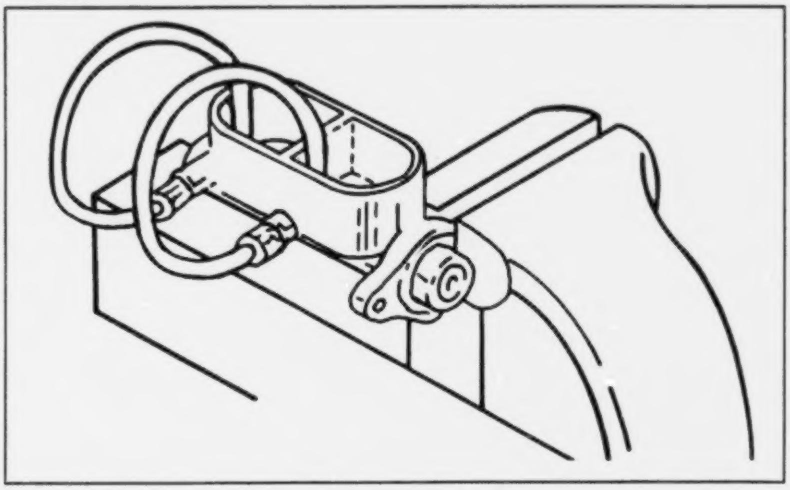
- Master specific job task/procedure
- Practice good work habits/attitudes

FIGURE 1



2. Connect short lengths of tubing to outlet ports and bend as shown in Figure 2.

FIGURE 2



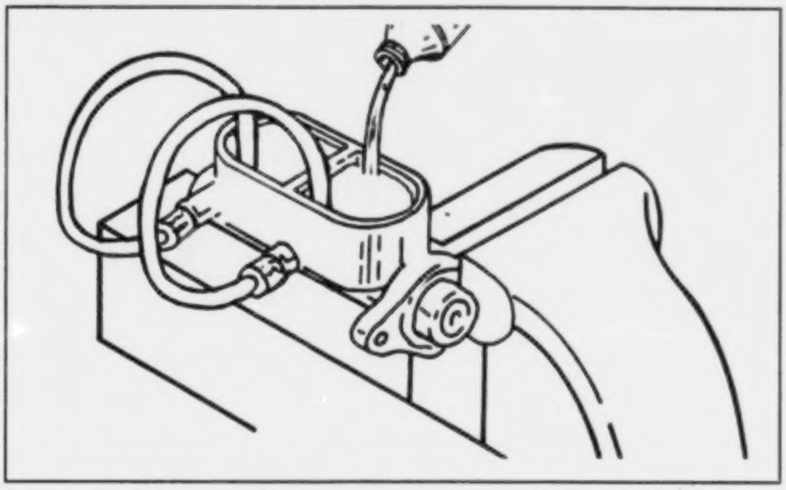
216

3. Fill reservoirs with fresh brake fluid, making sure that fluid level is well above ends of tubes. (Figure 3)

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

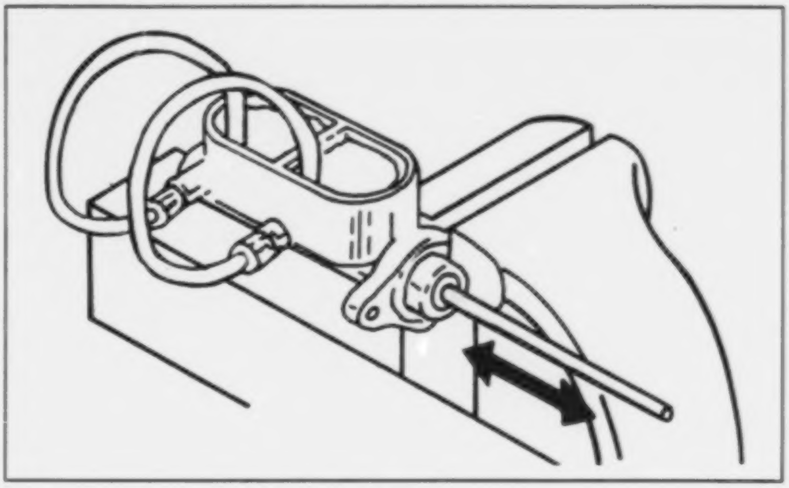
FIGURE 3



4. Slowly pump master cylinder with dowel or round-tipped rod until all bubbles stop appearing at tube ends; make sure that both pistons completely bottom in bore when you push dowel in and that both pistons return completely to the stop when you release dowel. (Figure 4)

NOTE: Slow piston return is normal on some master cylinders during bench bleeding.

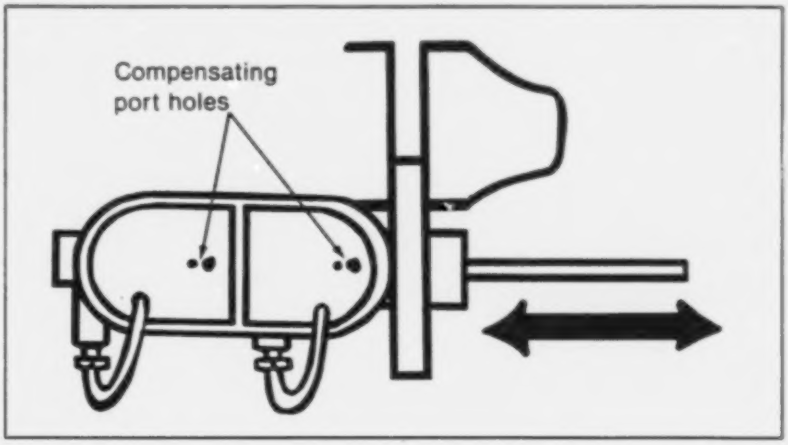
FIGURE 4



5. Push piston about ¼ to ½ inch in from fully released position, allow piston to return about ⅛ inch and then push it back to the initial ¼ to ½ inch.

6. Continue pumping rapidly in this manner until air bubbles stop coming from compensating ports located inside reservoirs. (Figure 5)

FIGURE 5



7. Remove bleeder tubes and refill reservoirs with brake fluid.

8. Securely install master cylinder diaphragm and cover.

9. Cover fenders and seats.

10. Install master cylinder on vehicle following service manual instructions and attaching lines but leaving tube connections loose.

11. Have helper slowly depress brake pedal and hold it to floorboard.

12. Tighten nuts at master cylinder tubing connections.

13. Have helper release brake pedal.

14. Loosen nuts at master cylinder tubing connections.

15. Continue this process several times to force out any air that may have been trapped in the connections, tightening nut slightly before releasing pedal and loosening it before depressing pedal each time.

16. Catch fluid in rag to avoid damaging vehicle finish.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

17. Tighten connections to manufacturer's specifications when air bubbles are no longer present in fluid.

18. Check master cylinder fluid level and refill with clean, approved brake fluid to at least three-quarters full if necessary.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

19. Before attempting to move vehicle, check brake pedal to be sure that it is firm and high.

20. Road test vehicle to check brake function.

◆ WARNING ◆

Before test driving any vehicle, check the fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

21. Clean work area and return equipment and materials to proper storage.

This job sheet is adapted from *Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual AU-1600/Feb.*, 1984, by Wagner Division, Cooper Industries, Inc.

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 32

Remove and replace a combination valve.

INTRODUCTION

A combination valve, as its name implies, combines all of the valves in a particular system. Such a valve can contain a pressure differential valve, a proportioning valve, and a metering valve. Combination valves are usually mounted on the frame, the bulkhead, or a side panel near the master cylinder. The position of such valves, their appearance, and their service procedures vary, even among vehicles made by the same manufacturer. Because of this, proper removal and installation procedures can be found only in the manufacturer's service manual. Certain guidelines, however, must be followed when replacing any hydraulic system valves. These guidelines are listed below.

Removal guidelines:

- Strictly adhere to all asbestos safety rules.
- Always use tubing or flare-nut wrenches to remove lines from valves.
- Always support valve with an open-end wrench when you loosen the fittings (pliers are needed in some instances).
- Loosen all fittings before you loosen supporting bolts or clamps.
- Take care not to bend tubing when you disengage the flared ends; bent tubing may cause misalignment problems during reinstallation.

Installation guidelines:

- Position all fittings and start all threads by hand.
- Do not use a wrench on any fitting until you are sure the threads are properly aligned and started.
- Do not tighten any fitting until all fittings have been started.
- After all fittings are hand-threaded in place, install attaching bolts or clamps.
- Use a tubing wrench to tighten all lines, supporting the valve if necessary.
- Thoroughly clean valve, fittings, and lines near valve to ensure detection of leaks.
- Bleed system in sequence specified by manufacturer.
- Check for leaks.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

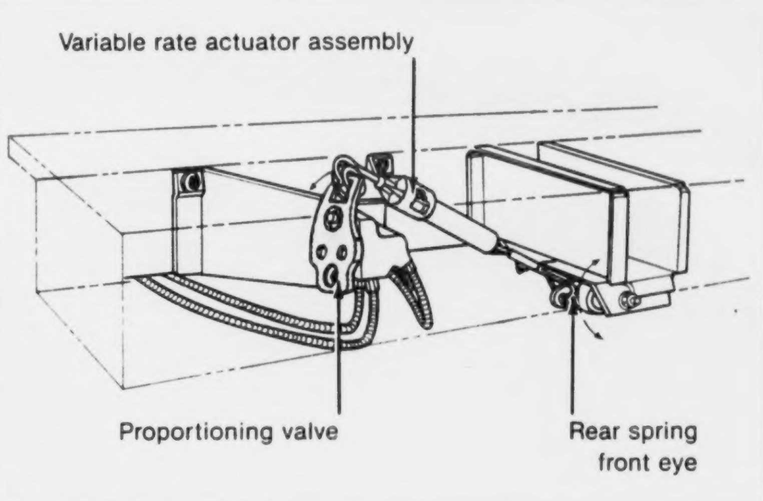
JOB SHEET 11 SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS I

OBJECTIVE 33 **Remove, adjust, and replace a load-sensing proportioning valve.**

INTRODUCTION

Load-sensing proportioning valves have been installed on some late-model vehicles. This system reduces the chance of rear wheel lockup while braking with a light cargo load and improves rear braking with heavier cargo loads. The system controls the amount of rear braking force according to the weight of the cargo load over the vehicle's rear axle. The load-sensing proportioning valve is mounted on the left side of the body or frame, and is connected to the rear axle through an actuator assembly. The actuator assembly contains two coil springs in series, thus providing a variable rate-of-increase of rear braking force with increasing cargo load. See Figure 1.

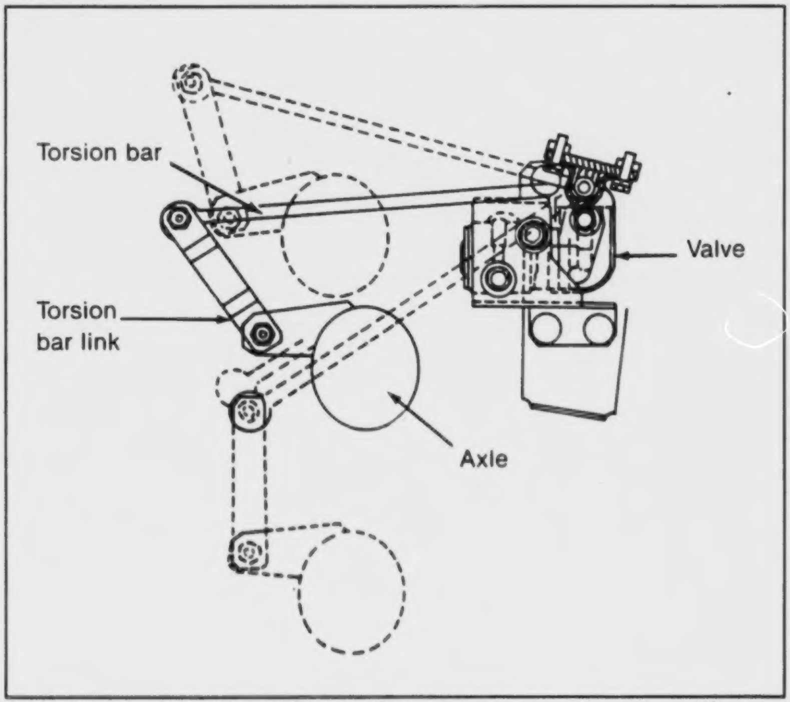
FIGURE 1



Used with permission of Chrysler Corp.

If there is a light load on the rear wheels—as when there are no rear seat passengers or luggage, or during a hard stop that transfers weight to the front wheels—the proportioning valve pivot arm controls pressure by moving with the body angle to restrict passage of pressure through the valve. (Figure 2)

FIGURE 2



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There should be no modifications whatsoever to this system. However, the Brakes Specialist should know how to remove and replace a load-sensing proportioning valve. Because removal and replacement procedures vary with vehicle make and model, the specialist must follow those procedures outlined in the appropriate service manual.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

OBJECTIVE 34

Check and adjust brake stop light and warning light systems.

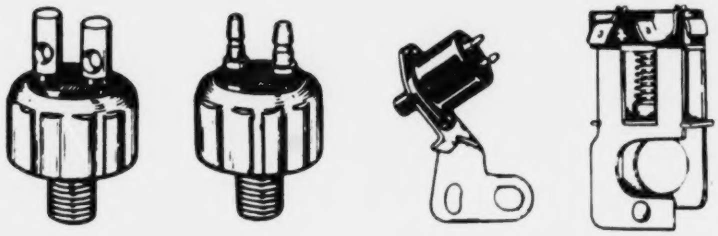
INTRODUCTION

Brake stop light switches

Brake stop light switches may be hydraulically or mechanically operated. They are basically spring-loaded electrical switches designed to turn the stop lights on when the brake pedal is depressed. Figure 1 shows both hydraulic and mechanical stop light switches. In either type, the circuit through the switch is open when the brake pedal is released. When the pedal is depressed, the circuit through the switch closes, energizing the stop lights.

The hydraulic switch is operated by hydraulic pressure developed in the master cylinder. The mechanical switch is operated by contact with the brake pedal or with a bracket attached to the pedal lever under the dash.

FIGURE 1



Hydraulic switches **Mechanical switches**

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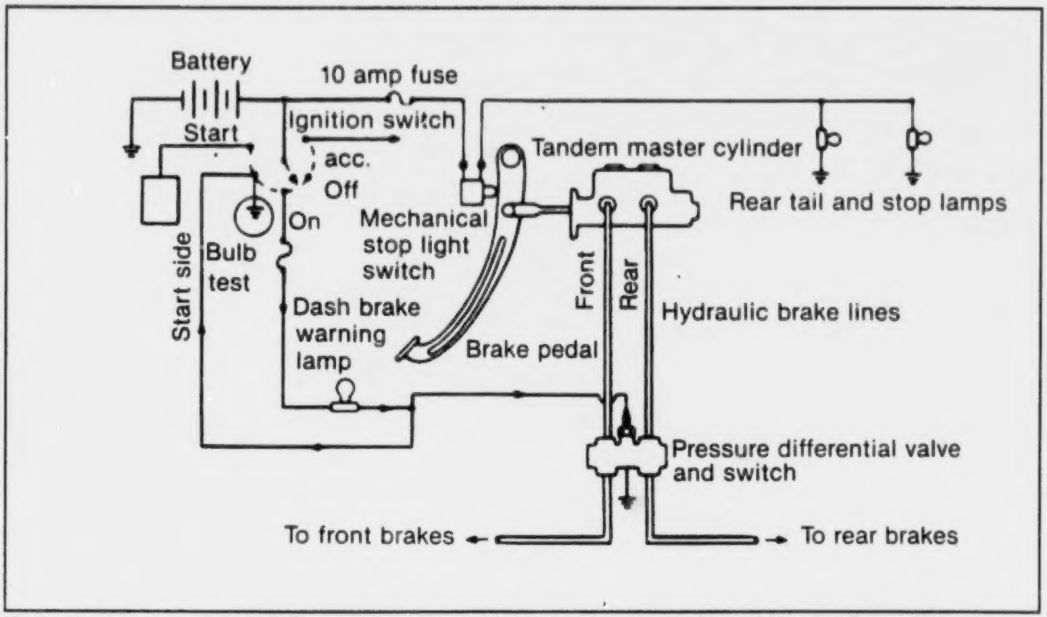
Brake warning light switches

The brake warning light switch (pressure differential valve) was first used on 1967 models, along with the dual system master cylinder. On some vehicles using disc brakes, beginning in 1970, this switch was combined with the proportioning valve into one housing. Usually, the valve body serves as a tubing junction, and the dual lines leading from the dual master cylinder are run parallel until joining the pressure differential valve and switch as shown in Figure 2.

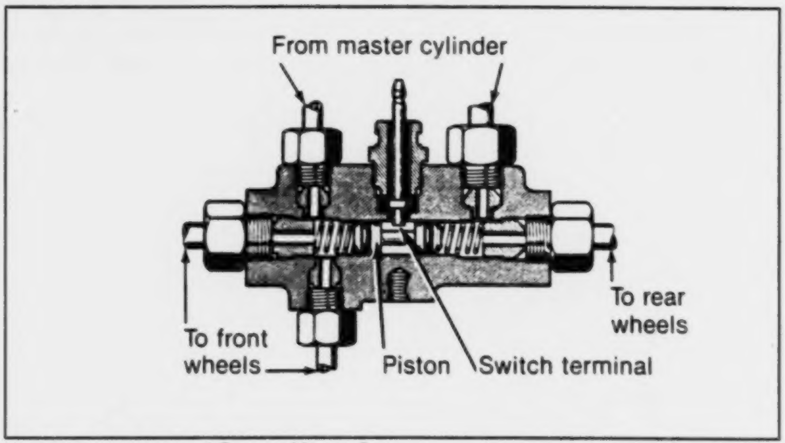
FIGURE 2


Battery
10 amp fuse
Ignition switch
Start
acc.
Off
On
Tandem master cylinder
Rear tail and stop lamps
Mechanical stop light switch
Start side
Bulb test
Front
Rear
Hydraulic brake lines
Dash brake warning lamp
Brake pedal
Pressure differential valve and switch
To front brakes
To rear brakes

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

When operating normally, there is equal pressure on both sides of the piston, and the piston is centered below the switch terminal (the ends of the piston do not contact the switch terminal) as shown in Figure 3. When a brake failure occurs in either the front or rear system, there is unequal pressure on each side of the warning light switch piston. This causes the piston to move toward the side with low pressure; the end of the piston then contacts the switch terminal, completing the circuit. The warning switch then activates a warning light on the dashboard.

FIGURE 3



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It is important that the brake stop light and warning light systems operate properly so that the vehicle can be driven without endangering the operator and passengers or people in other vehicles. The Brakes Specialist must be able to check and adjust these systems. There are some differences in the design of the switches in the brake stop light and warning light systems, and these differences make it necessary to refer to the appropriate service manual for proper service procedures.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

Job Acquisition/
Development Skills

- Master specific job task/procedure
- Practice good work habits/attitudes

JOB SHEET 13 — SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

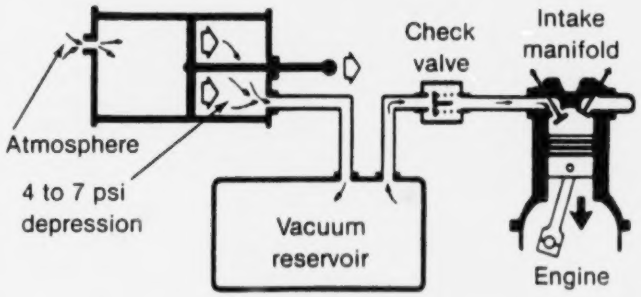
OBJECTIVE 35 **Inspect a vacuum power-assist unit and check valve for leaks and proper operation.**

INTRODUCTION

The power brakes found on most passenger cars and many commercial vehicles use vacuum power-assist units to supplement manual brake operation. Compressed-air boosters and full-powered air brakes are found only on heavier vehicles. Although the vacuum power brake units of various makes and models often appear quite different in shape or internal arrangement, these are mainly differences of structure, not of function. In most vacuum-powered systems, operating force is controlled by a valve mechanism and is exerted against the master cylinder piston when the brake pedal is depressed.

The vacuum power-assist unit obtains vacuum directly from the engine intake manifold or an engine-driven vacuum pump. (Figure 1)

FIGURE 1



Force = psi depression × area

EXAMPLE: 280 lb = 10 psi × 28 sq in

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EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Fender and seat covers

- Vacuum cylinder oil or nondetergent SAE 10 oil
- Approved brake fluid
- Vacuum gauge
- Brake System Inspection Report Form

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Functional Writing Skills
- Complete forms and records

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

NOTE: Be sure to note all inspection findings on your Brake System Inspection Report Form.

1. Cover fenders and seats.

2. Check master cylinder fluid level and fill to at least three-quarters full with clean, approved brake fluid if necessary.

   CAUTION

   Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

3. With engine off, operate brake pedal until system is devoid of vacuum.

4. Hold pedal down firmly, and then start engine; if pedal does not fall away or pull down from your foot—indicating the presence of power assist—check power unit for proper operation by performing the following steps.

5. Run engine up to medium speed, then release throttle and turn off engine.

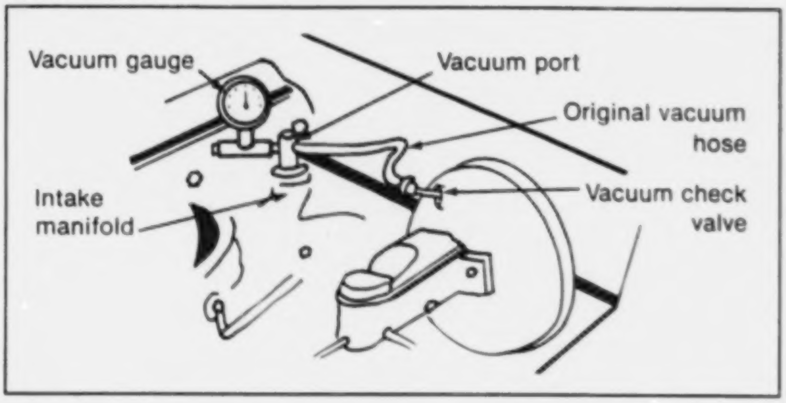
6. Wait for 1 or 2 minutes and then depress brake pedal.

   NOTE: Vacuum in the reservoir should provide at least one fully boosted brake application before it becomes more difficult for the driver to depress the brake pedal (the pedal feels harder and higher).

7. If you feel no power assist, the protection check valve or supply line is leaking, or vacuum supply is restricted to less than normal vacuum.

8. Attach a vacuum gauge to an intake manifold vacuum connection. (Figure 2)

FIGURE 2

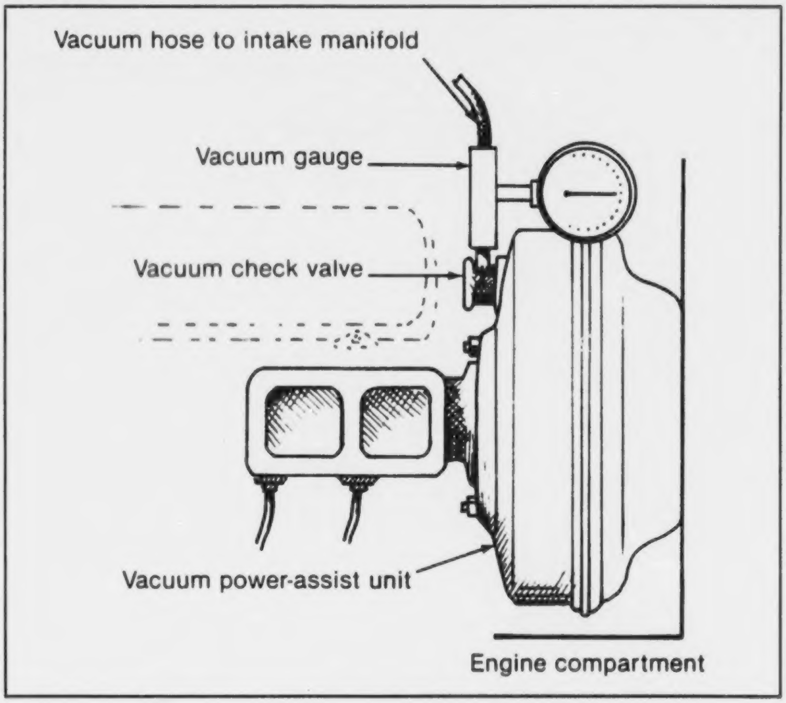

Vacuum gauge
Vacuum port
Original vacuum hose
Intake manifold
Vacuum check valve

9. Start engine and take vacuum reading at idle speed; gauge should read at least 10 inches of vacuum; if it reads less than 10 inches, see service manual for repairs necessary to correct this condition.

10. Turn off engine and remove vacuum gauge from engine connection.

11. Connect gauge in vacuum hose at vacuum power-assist unit check valve as shown in Figure 3.

FIGURE 3


Vacuum hose to intake manifold
Vacuum gauge
Vacuum check valve
Vacuum power-assist unit
Engine compartment

12. Start engine and take vacuum reading at idle speed; reading should be the same as that taken at manifold; if reading is lower, inspect for a leak or restriction in the hose.

13. Turn off engine.

14. Disconnect supply line at power unit and check it for presence of brake fluid; if brake fluid is present and unit is installed downstream from master cylinder, seals within unit are leaking; if unit is installed in pedal linkage, a vacuum seal within unit and the piston secondary seal in master cylinder are both leaking.

15. To check for reserve vacuum leaks, operate the engine at fast idle for 10 seconds and then turn it off.

16. Let vehicle stand for 10 minutes.

17. Apply brake pedal with approximately 20 pounds of force; if pedal feels hard, replace vacuum check valve and retest for leaks; if pedal still feels hard, replace power-assist unit.

18. Lubricate power-assist unit by inserting vacuum cylinder oil or nondetergent SAE 10 oil directly into cylinder through pipe plug or lead-in tube connection at end opposite vacuum supply line connection.

    NOTE: Vacuum-powered, piston-type units should be lubricated at brake inspection intervals; otherwise, a dry packing or cup lip could result in internal leakage or cause noisy operation.

19. If unit includes an air filter that can be cleaned, service it.

20. Check fluid level in master cylinder reservoir; refill with clean, approved brake fluid to at least three-quarters full if necessary.

    CAUTION

    Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

21. Road test vehicle.

    ♦ WARNING ♦

    Before test driving any vehicle, check fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

22. Clean work area and return equipment and materials to proper storage.

JOB SHEET 14 SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

OBJECTIVE 36

Inspect a hydraulic power-assist unit (mechanical pump) for leaks and proper operation.

INTRODUCTION

This hydraulic power-assist system differs from vacuum power-assist units not only in the source of power (hydraulic versus vacuum), but in the fact that it is also a part of another major subsystem of the vehicle—the power steering system. Therefore, problems or malfunctions in the steering system may affect the operation of the unit, just as a problem in the power unit may affect the steering system.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Fender and seat covers
- Power steering fluid recommended by vehicle manufacturer
- Approved brake fluid

CAUTION

Power steering fluid and brake fluid cannot be mixed. If brake seals contact steering fluid or steering seals contact brake fluid, seal damage will occur.

- Replacement steering pump belt if needed
- Booster seal kit
- Screwdriver
- Pliers
- Shop towels
- Replacement parts as needed
- Basin for catching accumulator fluid
- Torque wrench
- Brake System Inspection Report Form

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Reading Comprehension Skills
- Gain factual information

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Functional Writing Skills
- Complete forms and records

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

NOTE: Be sure to note all inspection findings on your Brake System Inspection Report Form.

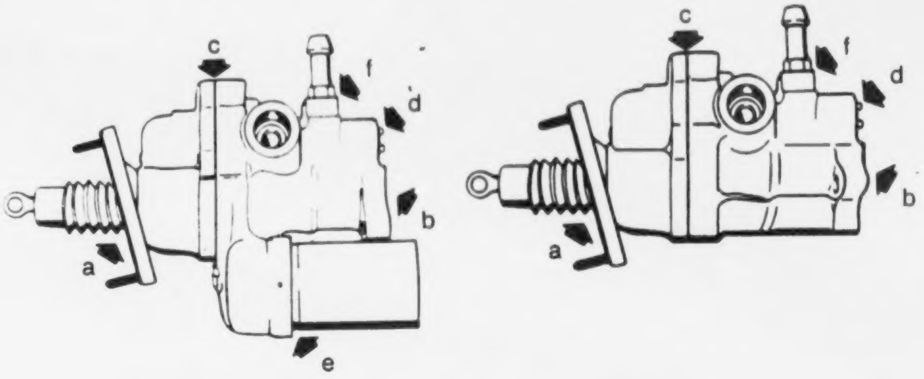
1. Cover fenders and seats.
2. Check all power steering and brake lines and connections for leaks and restrictions.
3. Check master cylinder fluid level and fill to at least three-quarters full with clean, approved brake fluid if necessary.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

4. Check fluid level in power steering pump reservoir; fill with power steering fluid, taking care not to mix the fluid with air.
5. Check power steering pump belt for tension and damage; replace if necessary.
6. Check engine idle speed and adjust according to service manual recommendations if necessary.
7. Check steering pump pressure and adjust according to service manual recommendations if necessary.
8. Check for seal leaks in appropriate locations as indicated on the illustrations of GM Hydro-Boost I and Hydro-Boost II systems in Figure 1.

FIGURE 1



Hydro-Boost I **Hydro-Boost II**

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a. **Input rod seal** — Check for fluid leak from mounting bracket vent hole; if seal is damaged, the booster must be removed from vehicle to replace seal.

b. **Power piston seals** — Check for fluid leaking at common master cylinder/brake booster vent; if seals are damaged, booster must be removed from vehicle and disassembled to repair.

NOTE: Check piston for scratches that may be causing a leak. If scratches are deep and extensive, replace piston following manufacturer's directions; if scratches are present but not excessive, replace appropriate seals with booster seal kit.

c. **Housing seal** — Check for fluid leaking out from between the two housings; if housing is damaged, the booster must be removed from vehicle and booster seal kit and used to replace housing and power piston seals.

d. **Spool valve plug O-ring seal** — Check for fluid leaking past plug; if seal is damaged, follow the steps below to replace it.

(1) Press in on spool plug and insert small screwdriver between snap ring and housing bore to unseat one side of spool plug snap ring from its groove in bore.

(2) Remove snap ring from its groove in bore.

(3) Withdraw plug from bore with pliers.

(4) Remove o-ring from plug and replace it with a new one.

(5) Clean any dirt or rust from plug bore with clean power steering fluid to make sure that no dirt or rust is introduced into power unit.

(6) Push end plug back into bore and secure it with new retaining ring.

e. **Accumulator O-ring seal (on Hydro-Boost I models only)** — Check for fluid leakage past accumulator cap; if seal is damaged, replace, following procedure recommended in vehicle service manual.

CAUTION

Before removing accumulator spring cap, place a basin under the power unit to catch fluid when the cap is removed. Also, before the cap is removed, the brake pedal should be pumped four or five times to deplete accumulator pressure.

f. **Return port fitting** — Check port for external leakage; if there is leakage, tighten fitting to specified torque; if fitting continues to leak, replace O ring under fitting.

9. Check high-pressure gear or pump port for leakage; if there is leakage, torque tube nut to manufacturer's specifications; if leakage persists, check for damaged tube flares and repair if needed; if tube flares are good, replace the tube seats.

10. To perform accumulator leakdown test, start engine and charge accumulator either by applying brake pedal (use about 100 pounds of pressure) or by turning steering wheel from stop to stop.

11. Turn off engine and allow vehicle to sit for 1 hour.

12. If system is Hydro-Boost I, apply brake pedal twice with engine off; if system is Hydro-Boost II, apply brake pedal once with engine off.

    NOTE: There should be enough residual pressure for two brake applications. If there is not enough residual pressure, the vacuum valve is leaking. Refer to vehicle service manual.

13. Perform a power unit function test by turning the engine off and applying the brake pedal several times until the accumulator is completely depleted of pressure.

14. Depress brake pedal (using approximately 40 pounds of force) and start engine; pedal should move down and then push back against your foot; if it does not, the power unit is defective and requires replacement.

15. Clean work area and return equipment and materials to proper storage.

JOB SHEET 15 — SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

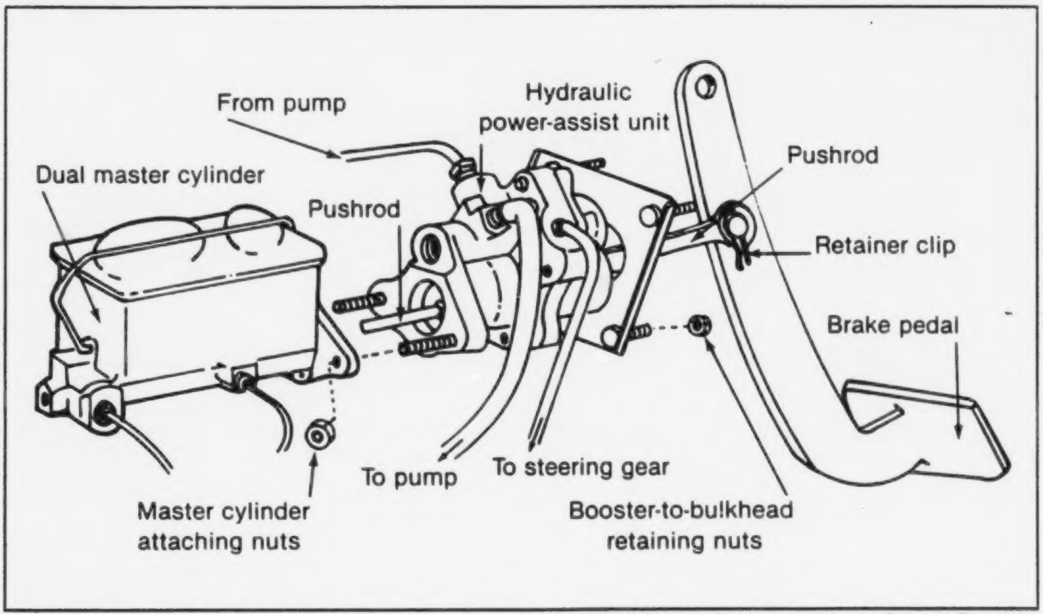
OBJECTIVE 37

Test, remove, and install a hydraulic power-assist unit (mechanical pump).

INTRODUCTION

With this type of power-assist unit, the power steering pump provides hydraulic fluid under pressure to the booster unit as well as to the power steering gear. The power-assist unit is mounted to the bulkhead and connected to the brake pedal by a pushrod that is an integral part of the power brake unit. A dual master cylinder is bolted to the power unit as shown in Figure 1 below, and is operated by the pushrod connecting them. In this design, an accumulator stores enough fluid under pressure to provide two power-assisted stops in case of a system pressure loss.

FIGURE 1


From pump
Hydraulic power-assist unit
Dual master cylinder
Pushrod
Pushrod
Retainer clip
Brake pedal
To pump
To steering gear
Master cylinder attaching nuts
Booster-to-bulkhead retaining nuts

From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service.* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Fender and seat covers
- Power steering fluid

- Approved brake fluid

CAUTION

Power steering fluid and brake fluid cannot be mixed. If brake seals contact steering fluid or steering seals contact brake fluid, seal damage will occur.

- Flare-nut or tubing wrench set
- Shop towels
- Bleeder screw wrench
- Torque wrench

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Cover fenders and seats.
2. Refer to service manual and perform the following preliminary checks:
    - Check for amount of brake fluid.
    - Check for correct amount of power steering pump fluid.
    - Check for proper tension in power steering pump belt.
    - Check for proper engine idle speed.
3. To test the hydraulic power-assist unit, turn the ignition off, pump brake pedal several times to deplete accumulator of all reserve fluid stored under pressure.
4. With transmission in NEUTRAL and brake pedal in applied position, start engine.
5. If brake pedal moves down slightly and then pushes back against your foot, the power-assist unit is operating correctly.
6. If no action is felt, the power-assist unit is defective and must be replaced.

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

CAUTION

Most power-assist units require the use of special tools and spring retaining devices for disassembly and assembly. Some manufacturers advise against any attempt to overhaul these units and do not list parts for them in their catalogs. For these reasons, most mechanics usually replace a faulty booster unit with a new unit or with one that has been overhauled by a shop that specializes in rebuilding booster units.

NOTE: On a hydraulic power-assist system, it is also necessary to perform an accumulator leakdown test to make sure that there is enough reserve accumulator pressure to stop the vehicle in case the engine stops running, the power steering belt breaks, or a loss of power steering fluid occurs. Refer to the appropriate service manual for this procedure.

7. To remove the hydraulic power-assist unit, turn the ignition off and apply brake several times to lower pressure in accumulator.

8. Remove nuts attaching master cylinder to power unit. (Figure 1)

   NOTE: It is not necessary to remove the brake lines.

9. Remove the three hydraulic lines from power unit. (Figure 1)

10. Remove pushrod retainer clip and then slide pushrod from brake pedal.

11. Remove booster-to-bulkhead retaining nuts and lift unit from bulkhead.

12. To install hydraulic power-assist unit, position power unit on bulkhead and then install the pushrod on the break pedal and lock it in place with its washer and retainer clip.

13. Install booster-to-bulkhead retaining nuts; torque to vehicle manufacturer's specifications.

14. Install master cylinder on power unit; torque master cylinder retaining nuts to vehicle manufacturer's specifications.

15. Install the three hydraulic lines on power unit.

16. Disconnect source of power to ignition system as specified in service manual.

    NOTE: On GM diesel engines, you must disconnect the 12-volt wire from the fuel injector pump.

17. Fill power steering pump reservoir with power steering fluid.

18. While engaging starter, pump brakes in order to purge air from system.

    CAUTION

    Do not turn the steering wheel until all air is purged from the system.

19. Check power steering reservoir fluid level; add power steering fluid if necessary.

20. Reconnect ignition system or diesel pump, following service manual instructions.

21. With transmission in NEUTRAL, start engine.

22. Pump brakes again, turning steering wheel one full cycle from left to right.

23. Check for fluid leaks.

24. Recheck fluid level in master cylinder reservoir and refill with clean, approved brake fluid to at least three-quarters full if necessary.

    CAUTION

    Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

25. Road test vehicle.

◆ WARNING ◆

Before test driving any vehicle, check fluid level in the master cylinder, and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

26. Clean work area and return equipment and materials to proper storage.

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

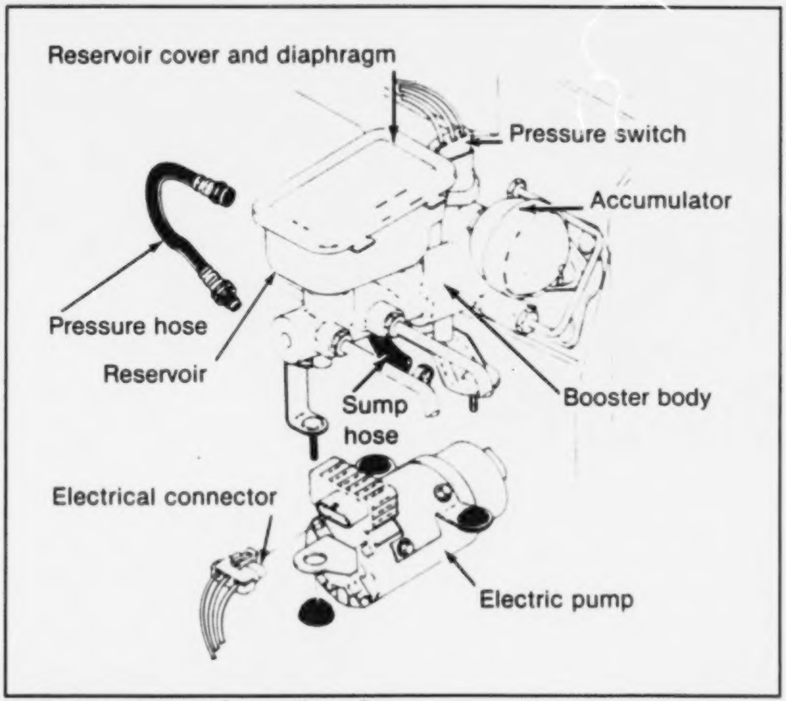
OBJECTIVE 38

Inspect and overhaul a hydraulic power-assist unit (electrical pump).

INTRODUCTION

This hydraulic power-assist system differs from the mechanically pumped hydraulic system in that it does not derive its pressure from the power steering system, but instead uses an electrical pump as shown in Figure 1 below. In this system,the nitrogen-charged accumulator stores fluid for hydraulic booster operation. The electric pump operates between pressure switch limits with the ignition ON. When the pressure switch senses accumulator pressure below specified limits, the pump operates to increase accumulator fluid pressure. When the brake pedal is depressed, fluid from the accumulator acts on the booster power piston to apply the master cylinder, which functions in the same manner as a conventional master cylinder.

FIGURE 1


Reservoir cover and diaphragm
Pressure switch
Accumulator
Pressure hose
Reservoir
Sump hose
Booster body
Electrical connector
Electric pump

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Because of design and installation variations, the Brakes Specialist must follow instructions in the vehicle service manual when servicing this type of power-assist unit. However, some general guidelines apply to all designs, and those are listed below.

Inspection guidelines:

- Be sure to note all inspection results on Brake System Inspection Report Form.
- Inspect all metal parts for cracks, distortion, or other evidence of structural damage.
- Inspect primary sealing surfaces on power piston for scoring, deep scratches, or other damage that could cause leakage; if noted, replace power piston assembly.
- Inspect power piston and master cylinder piston bores in booster body for scoring and corrosion; if noted, replace power brake assembly (bores must not be honed).
- Inspect all grommets and rubber parts for wear and deterioration; if noted, install new rubber parts as specified in service manual.
- Inspect for leaks at brake pedal pushrod, reservoir cover, hose and pipe connections reservoir attaching points, pressure switch, and accumulator.

Overhaul guidelines:

CAUTION

Most power-assist units require the use of special tools and spring retaining devices for disassembly and assembly. Some manufacturers advise against any attempt to overhaul these units and do not list parts for them in their catalogs. For these reasons, most mechanics usually replace a faulty booster unit with a new unit or with one that has been overhauled by a shop that specializes in rebuilding booster units. If you have to overhaul a power-assist unit, you should first study the procedure outlined by the unit manufacturer. Proceed only if the proper tools and equipment are available. Any attempt to disassemble a booster unit without using the proper tools and holding devices may release spring-loaded parts and cause you personal injury.

- Fully depressurize power unit before performing any service. Failure to depressurize the power unit could lead to personal injury and damage to painted surfaces.

- Perform any disassembly procedures on a clean bench free of all mineral oil.

- Take care not to scratch or otherwise damage sealing surfaces at pushrod end of power piston assembly and bores in booster body.

- Clean all parts except pressure switch and electric pump in denatured alcohol.

  NOTE: The exterior surfaces of the pump may be wiped with a cloth dampened with denatured alcohol, but neither the pump or the pressure switch should ever be wetted or immersed.

- Use clean, fresh brake fluid to lubricate parts before reassembly.

- Lubricate new rubber o-rings, grommets, and seals with clean brake fluid just before reassembly.

- Lubricate master cylinder and power piston bores in booster body before installing parts.

- Do not use lubricated shop air on brake parts as damage to rubber components may result.

- Follow service manual instructions for bleeding and filling booster unit and cycling pump.

- Follow service manual instructions for bleeding master cylinder section of power booster unit.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Functional Writing Skills
- Complete forms and records

Job Acquisition/ Development Skills
- Practice good work habits/attitudes

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

PRACTICAL TEST 1

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

JOB SHEET 1

Inspect, test, and service hydraulic brake lines and hoses.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Inspected lines, fittings, and hoses following outlined procedure for conditions listed in job sheet.	___	___
3. Selected correct replacement hoses and tubing.	___	___
4. Replaced brake lines and hoses following outlined procedures.	___	___
5. Observed safety rules and precautions.	___	___
6. Correctly filled out Brake System Inspection Report Form.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 2

Bleed or flush a hydraulic braking system.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Bled system at bleeder points in correct sequence.	___	___
3. Manually bled hydraulic system following outlined procedure.	___	___
4. Pressure bled hydraulic system following outlined procedure.	___	___
5. Surge bled hydraulic system following outlined procedure.	___	___
6. Observed safety rules and precautions.	___	___
7. Cleaned work area and returned equipment and materials to proper storage	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 3

Remove, clean, inspect, and repack (or replace and pack) wheel bearings and replace seals.

Student's name ______________________ Date ________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed brake bearing assemblies following outlined procedure.	___	___
3. Cleaned and inspected bearing assemblies correctly.	___	___
4. Correctly repacked bearing assemblies with bearing packer and/or by hand.	___	___
5. Reinstalled bearings, seals, brakes, and wheel assemblies correctly.	___	___
6. Observed safety rules and precautions.	___	___
7. Correctly filled out Brake System Inspection Report Form.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 4

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

JOB SHEET 4

Adjust wheel bearings.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Torqued spindle nut to manufacturer's specifications and seated bearings.	___	___
3. Correctly attached dial indicator and measured looseness in hub assembly.	___	___
4. Retorqued spindle nut to manufacturer's specifications, reinstalled nut lock, and new cotter pin.	___	___
5. Reinstalled dust cap on hub and replaced wheel cover.	___	___
6. Observed safety rules and precautions.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 5

Remove and replace front-wheel drive nonserviceable sealed wheel bearings.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed tire-and-wheel assemblies correctly.	___	___
3. Removed and suspended caliper correctly.	___	___
4. Removed bearings following procedure outlined.	___	___
5. Replaced bearings and reinstalled caliper and tire-and-wheel assemblies following procedure outlined in vehicle manufacturer's service manual.	___	___
6. Observed safety rules and precautions.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 6

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 6

Remove and replace a dual master cylinder.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed dual master cylinder following outlined procedure.	___	___
3. Replaced dual master cylinder following procedure correctly.	___	___
4. Adjusted brake pedal free play correctly and tested master cylinder vents at both ports.	___	___
5. Observed safety rules and precautions.	___	___
6. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 7

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 7

Remove and replace a take-up valve in a quick take-up master cylinder.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed quick take-up valve assembly following outlined procedure.	___	___
3. Installed replacement take-up valve following outlined procedure.	___	___
4. Reinstalled master cylinder reservoir and filled reservoir correctly.	___	___
5. Adjusted brake pedal for correct free play.	___	___
6. Bled hydraulic system.	___	___
7. Observed safety rules and precautions, including proper handling of brake fluid.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training

3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required

2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill

1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 8

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 8

Overhaul a master cylinder.

Student's name ______________________ Date ________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed master cylinder from vehicle following procedure outlined in vehicle manufacturer's service manual.	___	___
3. Disassembled, cleaned and inspected the master cylinder following outlined procedure.	___	___
4. Reassembled and reinstalled master cylinder following outlined procedure.	___	___
5. Bled brake system.	___	___
6. Checked master cylinder piston end play.	___	___
7. Observed safety rules and precautions.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 9

Bench bleed a master cylinder.

Student's name ____________________ Date ________

Evaluator's name ____________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Bench bled master cylinder following outlined procedure.	___	___
3. Installed master cylinder on vehicle following procedure outlined in vehicle manufacturer's service manual.	___	___
4. Removed air trapped in connections following outlined procedure.	___	___
5. Tightened connections to vehicle manufacturer's specifications.	___	___
6. Observed safety rules and precautions.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 10

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

JOB SHEET 10

Remove and replace a combination valve.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed combination valve following procedure outlined in vehicle manufacturer's service manual.	___	___
3. Installed combination valve following procedure outlined in vehicle manufacturer's service manual.	___	___
4. Thoroughly cleaned valve, fittings, and lines near valve.	___	___
5. Bled system in sequence specified by manufacturer.	___	___
6. Checked for leaks.	___	___
7. Observed safety rules and precautions.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Produce meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 11

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

JOB SHEET 11

Remove, adjust, and replace a load-sensing proportioning valve.

Student's name ____________________ Date __________

Evaluator's name ____________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed valve following procedure outlined in vehicle manufacturer's service manual.	___	___
3. Made adjustments following procedure outlined in vehicle manufacturer's service manual.	___	___
4. Replaced valve following procedure outlined in vehicle manufacturer's service manual.	___	___
5. Bled brake system.	___	___
6. Observed safety rules and precautions.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 12

Check and adjust brake stop light and warning light systems.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Properly prepared vehicle.	___	___
3. Checked and adjusted brake stop light system following procedure outlined in vehicle manufacturer's service manual.	___	___
4. Checked and adjusted brake warning light system following procedure outlined in vehicle manufacturer's service manual.	___	___
5. Completed service correctly.	___	___
6. Observed safety rules and precautions.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 13

Inspect a vacuum power-assist unit and check valve for leaks and proper operation.

Student's name ______________________ Date: __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Checked power unit for proper operation following outlined procedure.	___	___
3. Correctly determined seal leakage.	___	___
4. Checked for reserve vacuum leaks following outlined procedure.	___	___
5. Lubricated power-assist unit following outlined procedure.	___	___
6. Observed safety rules and precautions.	___	___
7. Correctly filled out Brake System Inspection Report Form.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 14

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

JOB SHEET 14

Inspect a hydraulic power-assist unit (mechanical pump) for leaks and proper operation.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Checked for seal leaks in appropriate locations and replaced parts as necessary.	___	___
3. Checked high-pressure gear or pump port for leakage, making corrections as necessary.	___	___
4. Performed accumulator leakdown test following outlined procedure.	___	___
5. Performed power unit function test following outlined procedure.	___	___
6. Observed safety rules and precautions.	___	___
7. Correctly filled out Brake System Inspection Report Form.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 15

Test, remove, and install a hydraulic power-assist unit (mechanical pump).

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Tested hydraulic power-assist unit following outlined procedure.	___	___
3. Correctly determined whether power-assist unit operates correctly or should be replaced.	___	___
4. Removed hydraulic power-assist unit following outlined procedure.	___	___
5. Installed hydraulic power-assist unit following outlined procedure.	___	___
6. Checked for fluid leaks.	___	___
7. Observed safety rules and precautions.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

JOB SHEET 16

Inspect and overhaul a hydraulic power-assist unit (electrical pump).

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Performed inspection and replaced parts as necessary following procedure outlined in vehicle manufacturer's service manual.	___	___
3. Inspected and serviced hydraulic power-assist unit correctly.	___	___
4. Cleaned and lubricated parts as recommended.	___	___
5. Observed safety rules and precautions.	___	___
6. Correctly filled out Brake System Inspection Report Form.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training

3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required

2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill

1 **Unskilled** - Is familiar with process, but is unable to perform job

WRITTEN TEST

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

Name ______________________________ Score __________

OBJECTIVE 1

Recognize definitions of terms associated with the brake hydraulic system by choosing the correct definition from lists of three choices. Write the letter of the correct definition in the blanks.

______ 1. **bleeding**

a. Process by which air and contaminants are removed from hydraulic system by draining part of the fluid or by operating system to work out these contaminants
b. Process by which dirt is removed from hydraulic fluid by aerating the fluid with compressed air
c. Process by which friction is reduced in hydraulic system by lubricating the system with silicone grease

______ 2. **brake**

a. Device used to slow, stop, or hold a vehicle by changing potential energy of motion into useless and wasted kinetic energy
b. Device used to slow, stop, or hold a vehicle by changing kinetic energy of motion into heat energy
c. Device used to slow, stop, or hold a vehicle by changing heat energy into useless and wasted kinetic energy

______ 3. **brake fluid**

a. Silicone-based liquid used in hydraulic brake systems to transmit force through tubing known as brake lines
b. Petroleum-based liquid used in hydraulic brake systems to transmit force through tubing known as brake lines
c. Non-petroleum-based liquid used in hydraulic brake systems to transmit force through tubing known as brake lines

May be photocopied for student use.

_____ 4. **asbestosis**

a. Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath
b. Fatal cancer of the lining of the chest or abdominal cavity caused by very low exposures to asbestos
c. Cell-destroying disease presently responsible for largest number of deaths from exposure to asbestos

_____ 5. **check valve**

a. Device that reduces pressure to rear wheels during hard braking
b. Device that prevents hydraulic pressure to front brakes until after rear brakes are applied
c. Device that allows air or liquid to pass in one direction only

_____ 6. **dual master cylinder**

a. Component of the hydraulic system that converts driver force to hydraulic pressure; contains four pistons, two each serving two wheel brakes
b. Component of the hydraulic system that converts driver force to hydraulic pressure; contains two pistons, each piston serving two wheel brakes
c. Component of the hydraulic system that converts driver force to hydraulic pressure; contains one piston that serves the two wheel brakes

_____ 7. **flushing**

a. Process of removing all air from hydraulic system and replacing it with new air
b. Process of using compressed air to remove all contaminants from hydraulic system
c. Process of removing all old fluid from hydraulic system and replacing it with new fluid

May be photocopied for student use

______ 8. **free-play (brake)**

a. Clearance between release bearing and pressure plate felt as motion at clutch pedal
b. Clearance between master cylinder actuator rod and piston assembly
c. Clearance between brake drum or disc and shoe or pad felt as clearance at brake pedal

______ 9. **hydraulic power-assist unit**

a. Device that uses hydraulic pressure supplied by intake manifold to assist in applying brakes
b. Device that uses vacuum pressure supplied by accumulator to assist in applying brakes
c. Device that uses hydraulic pressure supplied by power steering pump or electrically driven pump to assist in applying brakes

______10. **lung cancer**

a. Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath
b. Fatal cancer of the lining of the chest or abdominal cavity caused by very low exposure to asbestos
c. Cell-destroying disease presently responsible for largest number of deaths from exposure to asbestos

______11. **mesothelioma**

a. Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath
b. Fatal cancer of the lining of the chest or abdominal cavity caused by very low exposures to asbestos
c. Fatal cancer of the lining of the chest or nasal mucous membranes caused by prolonged exposure to asbestos

May be photocopied for student use.

______12. **overhaul**

a. To disassemble, recondition worn parts, replace defective parts, and reassemble a component or assembly
b. To remove a component or assembly and replace it with a new or reconditioned component or assembly
c. To machine or return a part to its original surface condition

______13. **recondition**

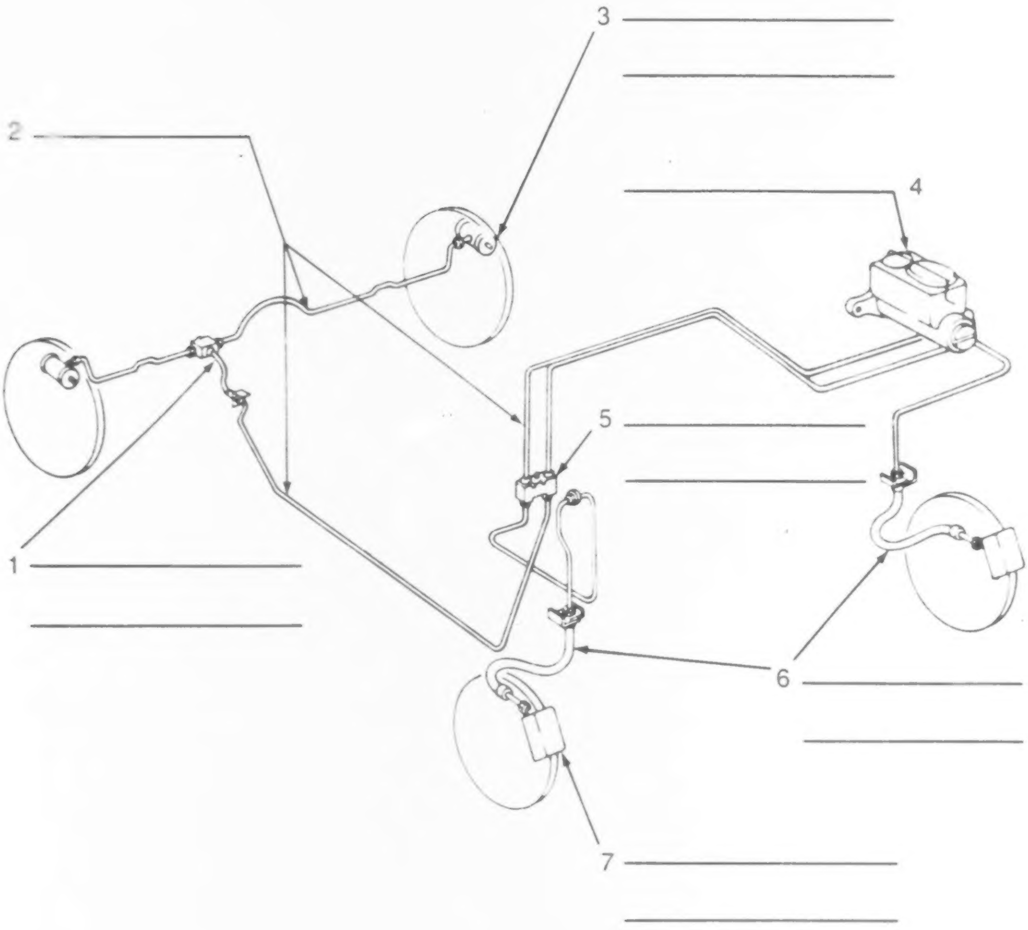
a. To machine or return a part to its original surface condition
b. To disassemble, clean, replace defective parts, and reassemble a component or assembly
c. To replace a component or assembly with one of the original diameter or state

______14. **vacuum power-assist unit**

a. Device that uses vacuum pressure supplied by accumulator to assist in applying brakes
b. Device that uses vacuum pressure supplied by intake manifold to assist in applying brakes
c. Device that uses vacuum pressure supplied by power steering pump or electrically driven pump to assist in applying brakes

May be photocopied for student use.

OBJECTIVE 2 | **Label the basic components of a hydraulic brake system indicated on an illustration.** Write the correct component names in the blanks.



Courtesy Chrysler Corp.

OBJECTIVE 3 | **List the steps of hydraulic brake operation in order.**

1. ____

____

May be photocopied for student use.

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

5. ______________________________

____

6. ______________________________

____

7. ______________________________

____

8. ______________________________

____

9. ______________________________

____

OBJECTIVE 4

Define the characteristics of good brake fluid. Write the characteristics of good brake fluid as it relates to each of the following key words.

1. **Viscosity** — ______________________________

____

____

May be photocopied for student use

2. **Boiling point** — ______________________________

____

____

3. **Corrosion** — ______________________________

____

____

4. **Water tolerance** — ______________________________

____

____

5. **Lubricating ability** — ______________________________

____

____

6. **Freezing point** — ______________________________

____

____

OBJECTIVE 5

Recognize guidelines for handling and storing brake fluid. Select guidelines for handling and storing brake fluid from the following list. Write an "X" in the blank before each correct guideline.

______ 1. Change brake fluid every 5000 miles, taking care not to spill fluid on any chrome or painted surface as it will damage these surfaces.

______ 2. Always keep brake fluid clean; do not allow any foreign material or petroleum product (gasoline, kerosene, oil, grease) to get into the fluid.

May be photocopied for student use.

______ 3. Always use an empty oil can to store fluid, as the oil acts to lubricate the lines.

______ 4. Always clean off top of fluid reservoir before refilling it in order to avoid contamination of brake fluid.

______ 5. Use largest possible can of brake fluid to fill master cylinder; use half a large can rather than two small cans.

______ 6. Loosely cap fluid container after use to allow gases to escape and to prevent explosion.

______ 7. Keep master cylinder tightly covered, and reinstall cover immediately after filling master cylinder with new fluid.

______ 8. Keep fluid reservoir in pressure brake bleeder loosely capped except when refilling.

______ 9. Store brake fluid away from heat or flame, as it is highly flammable.

OBJECTIVE 6

Complete statements describing hydraulic lines and fittings. Write the correct word or words in the blanks.

1. **tubing** — Hollow brake line of ______________ ______________ coated to resist rust and corrosion and ______________ ______________ at both ends to accept male fittings

2. **hose** — Hollow brake line of alternating layers of flexible ______________ and ______________ with threaded metal fittings at both ends

3. **hose end fittings** — Threaded metal fittings designed to ______________ both inside and outside of hose; generally one end accepts a ______________ fitting and the other end accepts a ______________ fitting

May be photocopied for student use

4. **double flare fitting** — Double lapped and flared steel tubing that is secured with a line or tube nut and requires a

_______________ _______________

5. **International Standards Organization (ISO) flare fitting** — Flare design that requires no _______________ _______________ and cannot be _______________ because shoulder of line or tube nut bottoms out in body of part, creating uniform pressure on flare

OBJECTIVE 7

Determine the correct specialty tool to use to service the hydraulic system and wheel bearings. Read the following service situations and then fill in the blank with the name of the tool that would be used.

1. You have removed, cleaned, and inspected the wheel bearings on a vehicle, and are now ready to pack new bearings before installing them. What tool would you use?

   Tool — ______________________________

2. You have just overhauled a master cylinder and have reinstalled it on the vehicle without first bench bleeding it. Now you are ready to reconnect the lines and bleed the hydraulic system. What tool would you use?

   Tool — ______________________________

3. You are pressure bleeding the front brakes on a vehicle, and you know that you must hold open the valve on the combination valve that delays front brake application because if you don't, you will introduce air into the rear brake system. What tool would you use to hold this valve open?

   Tool — ______________________________

4. You are replacing the brake lines on a vehicle. You have removed the old brake line, measured it, and obtained the replacement line. You need to shape the replacement line to the same configuration as the old line. What tool would you use?

   Tool — ______________________________

May be photocopied for student use.

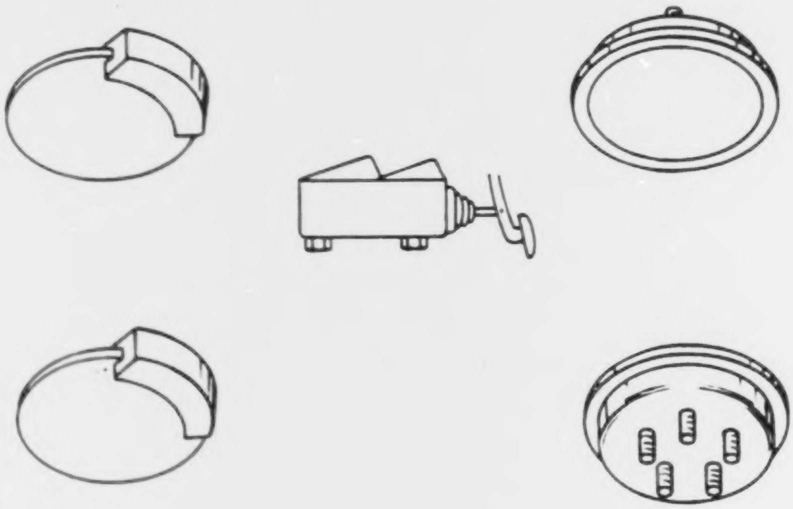
5. You are inspecting and checking a vacuum power-assist unit for proper operation and find that the check valve appears to be faulty. You want to test the engine vacuum supply. What tool would you use?

Tool — ______________________________

OBJECTIVE 8

Complete drawings of hydraulic circuits for dual braking system designs. Draw the hydraulic circuits for the designs below.

Diagonally split system



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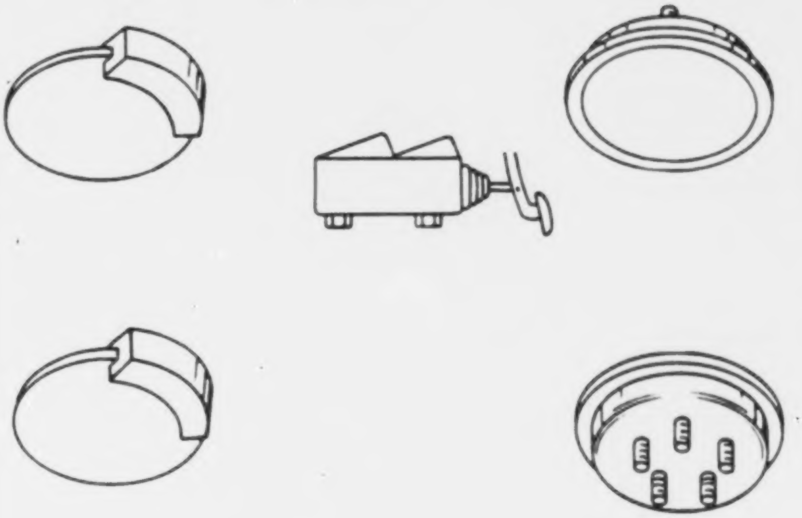
May be photocopied for student use.

Front-to-rear split system



Adapted with permission of Chilton Book Company, from *Chilton's Auto Repair Manual*, 1985..

OBJECTIVE 9

Evaluate asbestos safety practices. Evaluate each of the following case studies for asbestos safety violations. If no safety violation has been committed, leave the lines below the case study blank. If a violation has been committed, describe the safe procedure.

1. A Brakes Specialist is measuring and refinishing brake drums. She raises the vehicle and supports it properly on jack stands, removes the front wheel and drum, and properly places EPA-approved enclosure equipment over the hub assembly to form a tight seal.

May be photocopied for student use.

2. After adjusting and reinstalling brake shoes and related hardware, a Brakes Specialist sweeps up the work area with a wet broom and disposes of the sweepings in the shop waste barrel.

3. A Brakes Specialist wears assigned protective clothing at all times during brake service. He removes his protective clothing in the shop at the end of the day, and the shop sees to it that the clothing is professionally laundered.

4. A Brakes Specialist orders a new set of brake pads from a reputable supplier. Because the pads are of current manufacture, the specialist assumes that they are made of nonasbestos friction material and that the brakes can be serviced without the use of an enclosure system.

May be photocopied for student use

5. A Brakes Specialist uses compressed air to clean a disc brake assembly of asbestos dust and then wipes the brake assembly with a dampened rag that is disposed of in a sealed plastic bag.

____

____

____

____

OBJECTIVE 10

Match terms associated with wheel bearings to their definitions. Write the correct letter in the blanks.

______ 1. To adjust bearings so that they will work under mild pressure

______ 2. Thickness of a fluid; resistance to flow

______ 3. Part of bearing that contains outer race; installed in hub with a press fit

______ 4. Installation of a bearing cup with a tight or interference fit requiring more than hand pressure to install

______ 5. Part that transmits a load to a support and thus absorbs most of the friction and wear of the moving part

a. viscosity
b. preload
c. press fit
d. push fit
e. bearing race (cup)
f. end play (bearing)
g. bearing
h. race
i. bearing cone assembly
j. packing

May be photocopied for student use.

______ 6. Process of cleaning old grease from bearings and then forcing new wheel bearing grease into openings between races and ball or roller cages; may be done manually or mechanically

______ 7. Installation of a bearing cone assembly with a light fit that can be installed with hand pressure

______ 8. Part of roller bearing that contains inner race, roller cage, and rollers; installed on spindle with a push fit

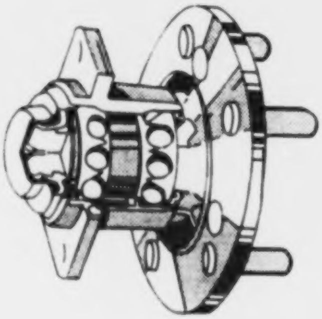
______ 9. Surface or path on which bearing balls or rollers move

______10. Amount of axial movement in hub due to clearance in bearings

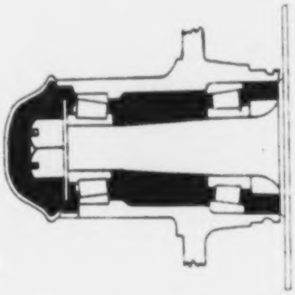
May be photocopied for student use

OBJECTIVE 11

Identify types of wheel bearings shown in illustrations. Write the correct names in the blank below the illustration.



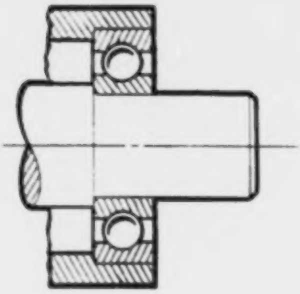
1. ____



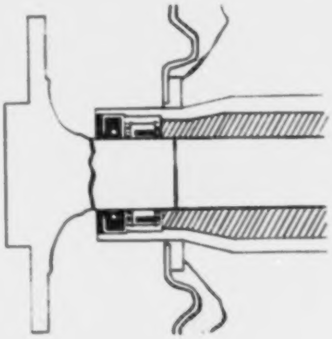
Used with permission of General Motors.

2. ____

May be photocopied for student use.



3. ______________________________



4. ______________________________

OBJECTIVE 12 **List the purposes of wheel bearings.**

- ______________________________

  ____

  ____

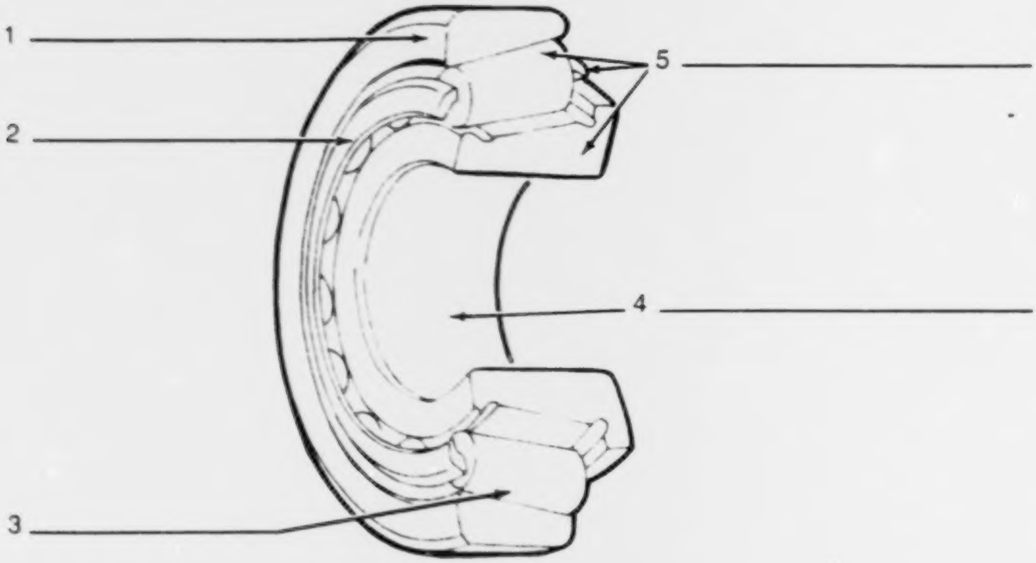
- ______________________________

  ____

  ____

May be photocopied for student use

OBJECTIVE 13 **Label the parts of a tapered roller wheel bearing indicated on an illustration.** Write the correct names in the blanks.



OBJECTIVE 14 **Recognize properties of wheel bearing grease.** Write an "X" in the blank before each correct statement.

______ 1. Is water-soluble

______ 2. Is heat-resistant

______ 3. Adheres to friction surfaces

______ 4. Is corrosive

______ 5. Is able to form acids under adverse conditions

______ 6. Is stable at high temperatures

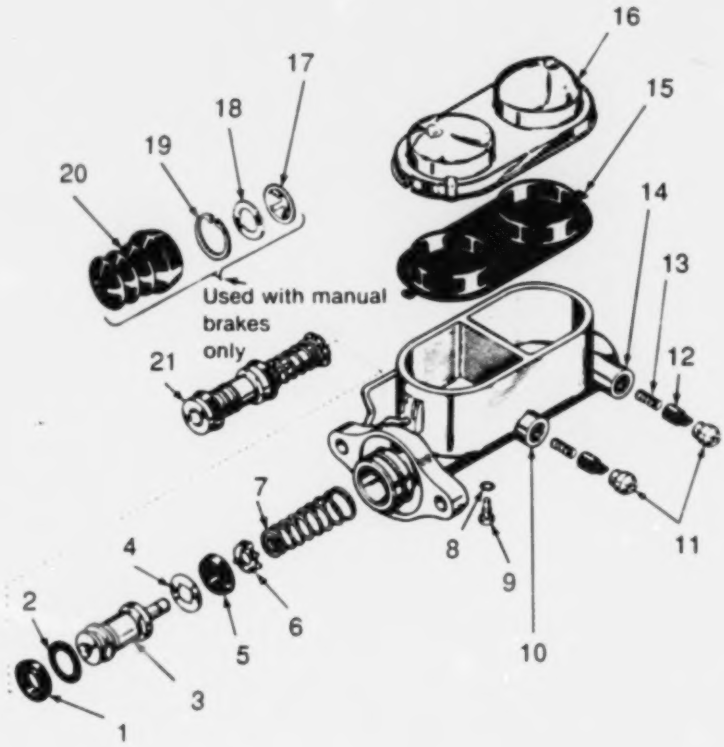
______ 7. Is water-resistant

______ 8. Is noncorrosive

May be photocopied for student use.

OBJECTIVE 15

Label the parts of a dual master cylinder indicated on an illustration. Use the blanks on the following page and write the correct names after the corresponding letters.


16
17
18
19
20
15
14
13
Used with manual brakes only
21
12
7
4
8
11
9
2
6
5
10
3
1

Adapted with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600 Feb., 1984.*

May be photocopied for student use

1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

6. ____________________

7. ____________________

8. ____________________

9. ____________________

10. ____________________

11. ____________________

12. ____________________

13. ____________________

14. ____________________

15. ____________________

16. ____________________

17. ____________________

18. ____________________

19. ____________________

20. ____________________

21. ____________________

May be photocopied for student use.

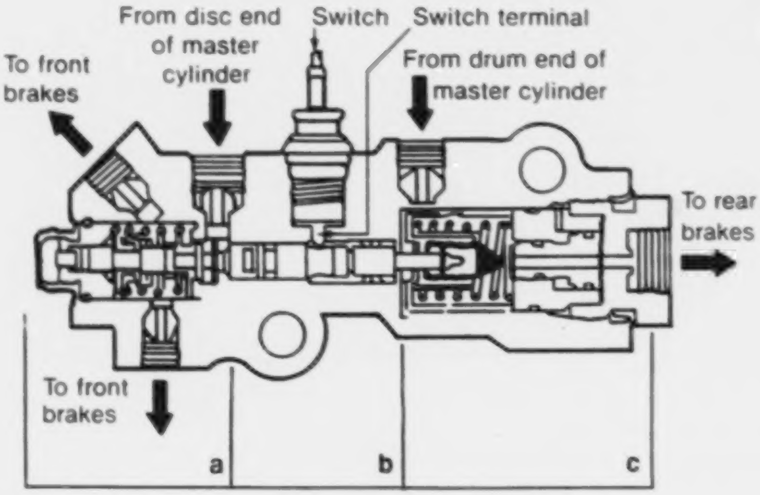
OBJECTIVE 16

Match the names and functions of combination valve components to an illustration. Write the correct letters in the blanks.

_______ 1. **Pressure differential valve** — Turns on a warning light if the pressure drops in one part of the system

_______ 2. **Proportioning valve** — Reduces pressure to rear wheels during hard braking

_______ 3. **Metering valve** — Delays hydraulic pressure to front brakes until after rear brakes are applied


From disc end of master cylinder
Switch
Switch terminal
To front brakes
From drum end of master cylinder
To rear brakes
To front brakes
a
b
c

From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

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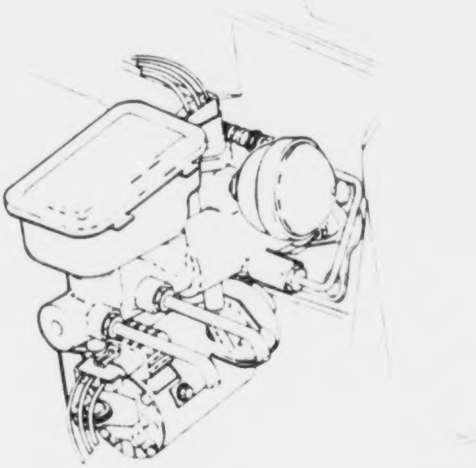
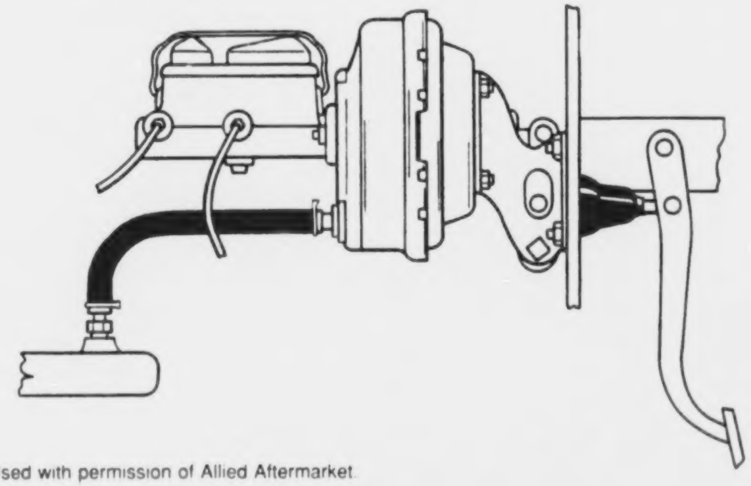
OBJECTIVE 17

Label types of power-assist units shown in illustrations. Write the correct name in the blank following the illustration.



Used with permission of General Motors Corp.

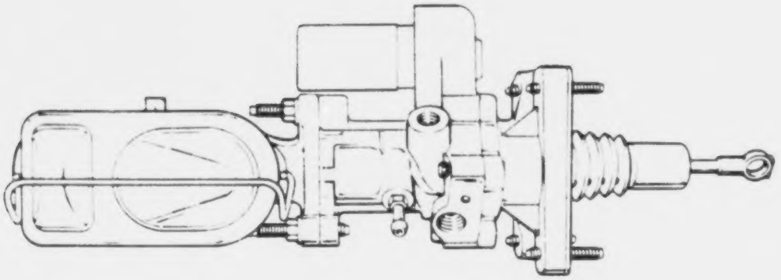
1. ______________________



Used with permission of Allied Aftermarket.

2. ______________________

May be photocopied for student use.



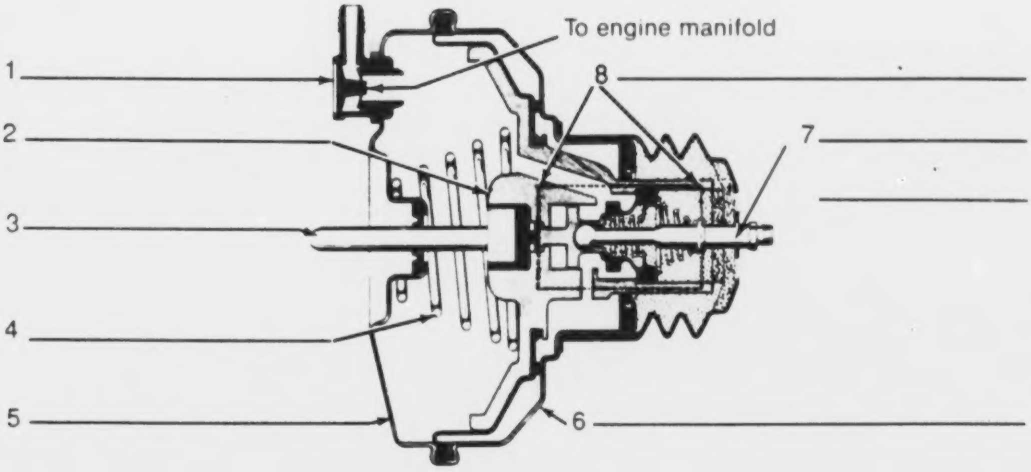
Used with permission of Ford Motor Co.

3. ______________________________

____

OBJECTIVE 18

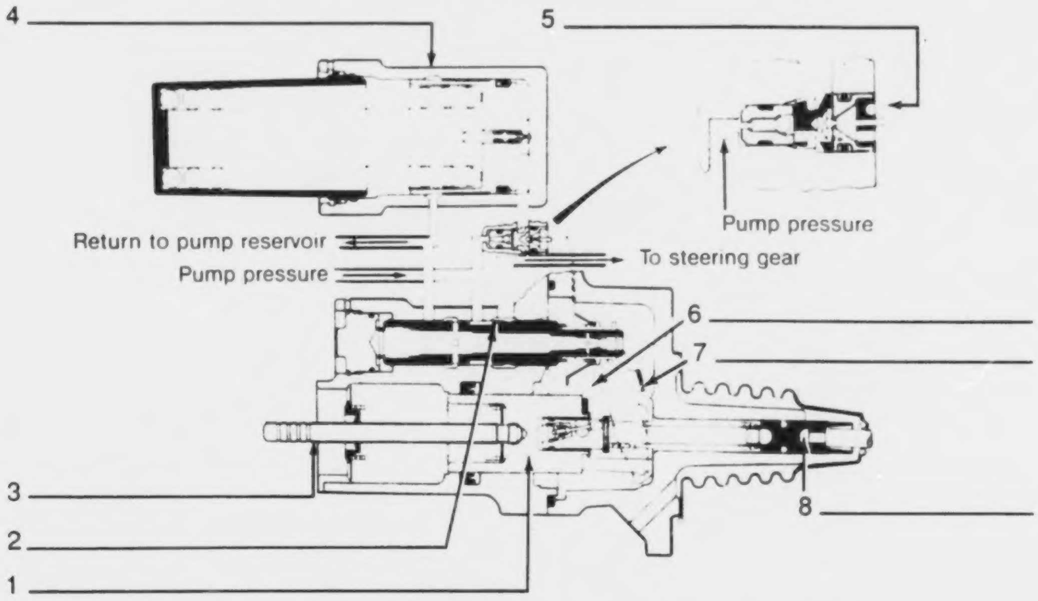
Label the parts of a vacuum power-assist unit indicated on an illustration. Write the name in the correct blank.



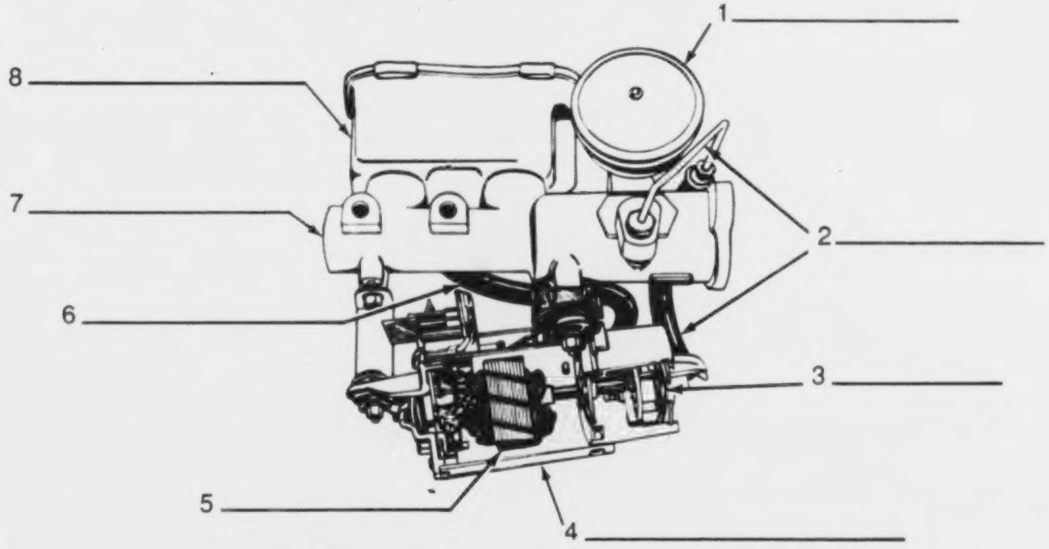
To engine manifold
1
2
3
4
5
6
7
8

May be photocopied for student use.

OBJECTIVE 19 | **Label the major parts of a hydraulic power-assist unit (mechanical pump) indicated on an illustration.** Write the names of the major parts in the blanks.


4
5
Pump pressure
Return to pump reservoir
To steering gear
Pump pressure
6
7
3
8
2
1

OBJECTIVE 20 | **Label the major parts of a hydraulic power-assist unit (electrical pump) indicated on an illustration.** Write the names of the major parts in the blanks.



May be photocopied for student use.

WRITTEN TEST ANSWERS

SERVICING BRAKE HYDRAULIC SYSTEM AND WHEEL BEARINGS

I

OBJECTIVE 1

1. a
2. b
3. c
4. a
5. c
6. b
7. c
8. b
9. c
10. c
11. b
12. a
13. a
14. b

OBJECTIVE 2

1. Rear brake hose
2. Brake lines
3. Rear wheel cylinder
4. Master cylinder
5. Combination valve
6. Front brake hoses
7. Front brake caliper

OBJECTIVE 3

1. Brake pedal is depressed.
2. Booster (if used) increases force into master cylinder.
3. Pushrod forces primary piston forward.
4. Fluid in primary cylinder is pressurized to apply front brakes.
5. Pressure in primary cylinder pushes secondary piston forward.
6. Secondary cylinder is pressurized to apply rear brakes.
7. Brake combination valve is used to delay (meter) front brake application; proportion rear pressure to front pressure; and trigger warning system.
8. Pistons in wheel cylinder push brake shoes against drum in drum-type brakes used on rear wheels.
9. Piston(s) in caliper forces brake pad against rotor in disc-type brakes used on front wheels.

OBJECTIVE 4

1. Should be free-flowing at all temperatures
2. Should have high boiling point so that it remains in liquid state at highest operating temperatures encountered
3. Should be noncorrosive so that it does not attack rubber or metal parts and should act as antirust agent
4. Should be able to absorb and retain moisture that collects in system
5. Should lubricate pistons and cups to reduce wear and internal friction
6. Should have low freezing point so that it remains fluid and flows at low ambient and operating temperatures

OBJECTIVE 5

2, 4, 7, 9

OBJECTIVE 6

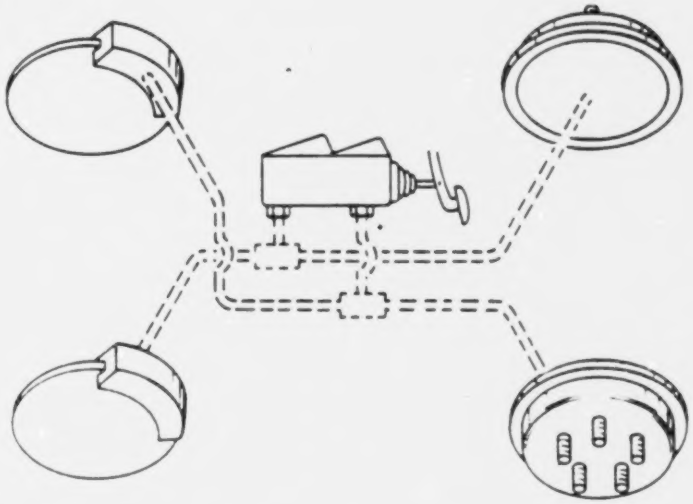
1. Bendable steel; double flared
2. Rubber; fabric
3. Grip; male; female
4. Tube seat
5. Tube seats; overtightened

OBJECTIVE 7

1. Wheel bearing packer
2. Brake pressure bleeder
3. Metering valve tool
4. Lever-type tubing bender
5. pressure gauge

OBJECTIVE 8

Diagonally split system



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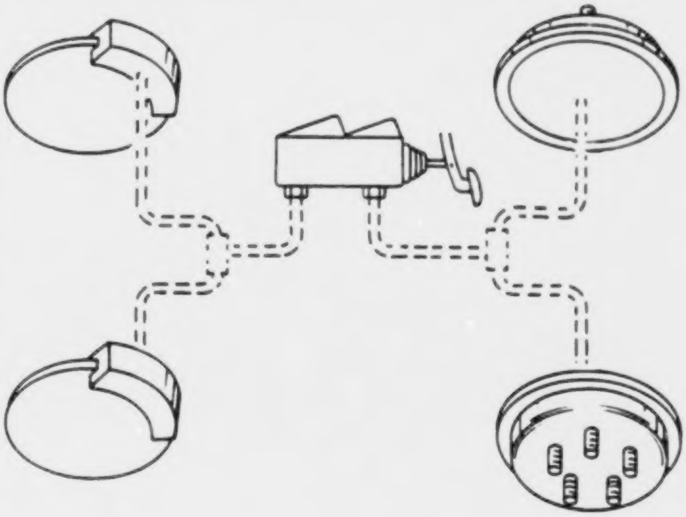
Front-to-rear split system



Adapted with permission of Chilton Book Company, from *Chilton's Auto Repair Manual*, 1985.

OBJECTIVE 9

1. She must install the enclosure equipment before removing drum.
2. The area where brake work is done should never be swept; a vacuum equipped with a HEPA filter must be used, and waste must be disposed of according to EPA's asbestos-disposal guidelines.
3. No safety violation committed
4. While the manufacture of nonasbestos brake linings is increasing, unless the specialist is certain that the linings contain no asbestos, he or she should use an enclosure system.
5. Compressed air should never be used without an enclosure system as it spreads asbestos particles; a damp rag does not prevent scattering of asbestos; an OSHA-approved enclosure cleaning system should be use.

OBJECTIVE 10

1. b
2. a
3. e
4. c
5. g
6. j
7. d
8. i
9. h
10. f

OBJECTIVE 11

1. Integrated ball bearing (sealed bearing)
2. Tapered roller bearing
3. Ball bearing
4. Straight roller bearing

OBJECTIVE 12

- To reduce friction between revolving wheel hub and spindle
- To spread vehicle loads over a larger surface area

OBJECTIVE 13

1. Outer race (cup)
2. Cage
3. Roller
4. Inner race
5. Cone assembly

OBJECTIVE 14

2, 3, 6, 7, 8

OBJECTIVE 15

1. Secondary cup
2. O-ring
3. Secondary piston
4. Cup washer
5. Primary cup
6. Cup protector
7. Return spring
8. O-ring
9. Piston stop bolt
10. Rear brake outlet
11. Tube seats
12. Residual pressure check valve
13. Check valve spring
14. Front brake outlet
15. Diaphragm
16. Cover
17. Pushrod retainer
18. Retainer
19. Snap ring
20. Boot
21. Primary piston

OBJECTIVE 16

1. b
2. c
3. a

OBJECTIVE 17

1. Hydraulic power-assist unit with electrical pump
2. Vacuum power-assist unit
3. Hydraulic power-assist unit with mechanical pump

OBJECTIVE 18

1. Vacuum check valve
2. Power piston
3. Master cylinder pushrod
4. Power piston return spring
5. Rear housing
6. Front housing
7. Brake pedal pushrod
8. Floating control valve

OBJECTIVE 19

1. Booster piston
2. Control valve
3. Output rod
4. Accumulator
5. Accumulator control valve
6. Booster pressure chamber
7. Control valve reaction lever
8. Input rod

OBJECTIVE 20

1. Accumulator
2. Supply hose
3. Pump
4. Pump and motor housing
5. Electric motor
6. Return hose
7. Master cylinder body
8. Master cylinder reservoir

OBJECTIVE SHEET

SERVICING DRUM BRAKES

II

INTRODUCTION

All four wheels on an automobile are brake units that stop the car by changing motion to heat. For many years, drum brakes were used on all four wheels. Today, drum brakes have been almost totally replaced at the front wheels by disc brakes. However, drum brakes are still used at the rear wheels of most new American automobiles. Small drum parking brakes are also used in the rear wheel rotors of some four-wheel disc brake systems.

PREREQUISITE

Before studying this unit the student should have successfully completed Unit 1, *Servicing Brake Hydraulic System and Wheel Bearings.*

UNIT OBJECTIVE

After completing this unit, the student will be able to diagnose drum brake problems and service drum brake systems. The student will demonstrate these competencies by completing the assignment sheet, job sheets, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to:

1. Recognize definitions of terms associated with drum brakes by choosing the correct definitions from lists of three choices.

2. Recall uses of specialty tools used to service drum brakes by writing the correct use when given the name of a specialty tool.

3. Recall steps in drum brake operation by listing the steps in correct sequence.

4. Recall components of typical duo-servo and non-servo brake assemblies by labeling the components shown on an illustration.

5. Recognize the functions of components of a duo-servo brake assembly by matching components to their correct functions.

6. Recognize definitions of terms associated with brake drum problems by matching terms to their correct definitions.

7. Recall defects to look for when visually inspecting drum brake components by listing defects for given component names.

8. Recall common types of brake shoe mountings by writing the correct names for given illustrations.

9. Recall basic components of a typical wheel cylinder by writing the names of components shown on an illustration.

10. Recall types of wheel cylinders used with drum brakes by writing the correct names for given illustrations.

11. Recognize types of automatic drum brake shoe adjusters by labeling illustrations with the correct names.

12. Diagnose drum brake problems. (Assignment Sheet)

13. Remove, clean, and visually inspect brake drums. (Job Sheet 1)

14. Measure and refinish brake drums. (Job Sheet 2)

15. Remove, clean, and inspect brake shoes and related hardware. (Job Sheet 3)

16. Remove, recondition, and reinstall a wheel cylinder. (Job Sheet 4)

17. Adjust brake shoes and reinstall shoes, related hardware, and drums or drum/hub assemblies. (Job Sheet 5)

18. Adjust an integral parking brake. (Job Sheet 6)

SERVICING DRUM BRAKES

PREPARATION

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the Delivery section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the Suggested Resources section. Include in your selection media that demonstrate job-sheet skills. Videotape your own demonstrations of job-sheet procedures if unable to obtain suitable media.

- Obtain Competency Profiles for this unit. See ordering information in the Suggested Resources section.

- Prepare classroom and shop. Display posters, charts, safety signs, etc., related to drum brake service. Have articles, specification guides, mock-ups, component displays, and other drum brake service resource material available for student reference. Display various types of brake drums, brake adjusters, and related hardware.

- The Written Test should be given as a pretest so that identified competencies can be accurately measured.

- Use the section in the Upfront to assist you in assessing student competencies.

- Consider the pretest results as you prepare your presentation for each objective.

DELIVERY

Unit Introduction

- Discuss the Introduction to the unit in the Objective Sheet.

- Discuss the Unit Objective and then the Specific Objectives. Emphasize how accomplishing the Specific Objectives will lead to meeting the unit objective and how reaching the unit objective is vital to becoming a Brakes Specialist. Also relate the objectives to your introduction and to materials previously covered.

- Provide students with the Raybestos *Pit Stop for a Brake Clinic* brochure and show the film that comes with this kit. After the film, give the students the quiz, explaining that the quiz is patterned after the brake portion of the NIASE Mechanic Certification Test. Discuss quiz questions and answers with the class.

- Use Transparency 1, Components of a Tandem or Dual Brake System, to introduce students to the typical components of this brake system with rear drum and front disc brakes.

- Review asbestos safety, stressing the absolute necessity for avoiding inhalation of asbestos particles.

- Tour the shop, pointing out equipment and materials involved in servicing drum brakes.

Objective 1: Recognize definitions of terms associated with drum brakes by choosing the correct definitions from lists of three choices.

- Point out examples of appropriate terms in the shop and make examples available in the classroom.

- Show samples of various types of drum brakes.

- Show students the primary and secondary shoes (front and rear shoes on non-servo brakes) on servo and non-servo drum brakes. Point out differences in lining length and position. Discuss the reasons for these differences.

- Show students a labyrinth seal to illustrate that term and the term *flange.*

- Show students the pawl on a drum brake adjuster.

- Demonstrate honing.

- Show students the location of the residual valve on a vehicle and discuss its function.

- Discuss the terms *self-energizing* and *servo action*.

Objective 2: Recall uses of specialty tools used to service drum brakes by writing the correct use when given the name of a specialty tool.

- Show students an example of each of the tools listed in this objective and demonstrate the use of each tool, allowing each student to repeat the demonstration.

- Where applicable, show students alternative tools that may be used to accomplish a task.

- EXAMPLE: Using a thin screwdriver or a welding rod with a brake spoon

- Discuss the care and maintenance of each tool and show students the proper shop storage location for each of the tools. Stress the need for returning tools to proper storage.

- Show students the enclosure-type brake cleaner, stressing the importance of protection from asbestos particles, but reserve your demonstration for Objective 13. (Job Sheet 1) Do the same with the drum brake lathe, reserving your demonstration for Objective 14. (Job Sheet 2)

- Point out that the enclosure-type cleaner is included as a specialty tool used with drum brakes, but that it must be used with disc brakes as well, to protect the technician from harmful asbestos particles.

- Show students brake adjusting spoons for different makes and models of automobiles. Demonstrate various designs, explaining the reasons for these design variations.

- Allow students to practice using the brake drum micrometer and drum-to-shoe gauge until they are proficient.

- Have students complete Activity Sheet 1, Determining Correct Specialty Tools For Servicing Drum Brakes.

Objective 3: Recall steps in drum brake operation by listing the steps in correct sequence.

- Discuss braking action in general, reviewing hydraulic principles and friction.

- Use the filmstrip, *Brakes: Principles and Components*, to expand on the basic principles outlined in this objective. Hold a question and answer session after viewing the filmstrip.

- Demonstrate centrifugal force and the natural inclination of an object to move in the direction of rotation. Set up a record player, tape a cardboard rim around an old record, and place the record on the turntable. Then place a checker near the center of the record, adjust record player to slowest speed, and turn on the player. The checker will move to the outer rim of the record and will move in the direction of rotation. Explain that hydraulic pressure, rather than centrifugal pressure, pushes brake shoes against the rotating drum, but the shoes then try to rotate with the drum like the checker. This self-energizing action supplements hydraulic pressure.

- Discuss Figure 15.

Objective 4: Recall components of typical duo-servo and non-servo brake assemblies by labeling the components shown on an illustration.

- Combine this objective with Objective 5, explaining the function of each component of the duo-servo assembly as you name each of the parts.

- Show students examples of various duo-servo and non-servo brake assemblies. Point out and explain the reasons for design differences.

- Provide students with copies of Extensions and Options 2, Types of Import Drum Brakes, for future reference.

- Display the *Lee Import Drum Brake Assemblies* wall chart. Discuss the chart in conjunction with Extensions and Options 2 illustrations.

- Provide students with the Bendix *Brake System Schematic* or display the schematic in the classroom or shop.

- Pair students and have each team quiz each other on the names and locations of the components of duo-servo and non-servo brake assemblies.

Objective 5: Recognize the functions of components of a duo-servo brake assembly by matching components to their correct functions.

- Explain the differences between duo-servo and non-servo brake function. Use the boxed material, *Servo Action*, to assist you in your explanation.

- Using a duo-servo brake assembly that has been removed from a vehicle, explain the function of each component as you name each of the parts.

- Pair students and have each team quiz each other on the functions of the components of a duo-servo brake assembly.

- Explain that *duo* means "two" and thus that duo-servo action indicates that servo action is supplied in both forward and reverse directions.

Objective 6: Recognize definitions of terms associated with brake drum problems by matching terms to their correct definitions.

- Show students examples of defective drums or drum brake hardware to illustrate each of the terms listed.

- Collect defective drums or drum brake hardware illustrating each of the problems listed and display these components on a table. Number each with a three-by-five card and have students identify and write down the correct term for each problem displayed.

Objective 7: Recall defects to look for when visually inspecting drum brake components by listing defects for given component names.

- Pair students and have each team perform a visual inspection of drum brake components on a live automobile. Have students use the table in this objective as a checklist, each team checking those items that they find defective.

- Demonstrate a visual inspection of an automobile brake system, pointing out any drum brake component defects found. Explain the different conditions or symptoms caused by these defects.

- Show students examples of each of the defects listed in this objective, display drums with each of the defects listed in Supplement 2, Causes of Drum Brake Defects, and discuss in class.

Objective 8: Recall common types of brake shoe mountings by writing the correct names for given illustrations.

- Show students examples of each type of mounting.
- Use Transparency 2, Parts of a Typical Drum Brake Shoe, when discussing brake shoe mountings.
- Exhibit two types of mountings and have students identify each.
- Explain the relationship between mounting types and servo or non-servo action.
- Discuss the advantages of one type over another.
- Discuss information presented in Extensions and Options 1, Characteristics of Good Brake Linings.

Objective 9: Recall basic components of a typical wheel cylinder by writing the names of components shown on an illustration.

- Show students the location of the wheel cylinders on various makes and models of vehicles.
- Remove a double-piston straight-bore wheel cylinder from a vehicle and disassemble it, naming and noting the location of each component as it is disassembled.
- Review the hydraulic principles used to activate wheel cylinders as explained in the boxed material, *Wheel Cylinder Operation.*
- Pair students and provide each team with a wheel cylinder. Have the teams quiz each other on the locations and names of the components.

Objective 10: Recall types of wheel cylinders used with drum brakes by writing the correct names for given illustrations.

- Show students examples of each of the types of wheel cylinders used with drum brakes.
- Discuss boxed material, *Design Variations*. Also discuss fixed, floating, and sliding single-piston wheel cylinders.
- Exhibit the different types of wheel cylinders and have students identify each different type.
- Point out that normally front-engine passenger cars equipped with drum brakes use a larger-diameter wheel cylinder on the front axle brakes and explain why.
- Show students a wheel cylinder with a baffle. Explain that this type of wheel cylinder is used on smaller-diameter forward front brakes to eliminate the clunking noise heard when the direction of braking is changed from forward to reverse or from reverse to forward. Explain that a baffled wheel cylinder should not be reconditioned with a cylinder hone because the baffle prevents uniform honing and may leave burrs on the cylinder bore or the baffle, which could affect the safe operation of the wheel cylinder. Baffled cylinders should be replaced as a unit.
- Show students an aluminum wheel cylinder and explain that aluminum wheel cylinders should not be honed if pitted or corroded. This type of wheel cylinder should be replaced as a unit.
- Explain to the students the use of the expander in the wheel cylinder and that this device is used on many vehicles in place of the residual valve in the master cylinder. This device keeps the cup seal lip snug against the cylinder bore to prevent leakage of air into the cylinder.
- Explain that on many vehicles the wheel cylinders can be disassembled without removing the cylinder from the backing plate. Explain also that on some brakes the cylinder is mounted in an indentation in the backing plate and the piston stop is welded to the plate, necessitating removal before disassembly. Show students examples of each type of mounting.

- Recommend that students always use a wheel cylinder repair kit to recondition a wheel cylinder, that they dip the piston cups in clean brake fluid and coat the cylinder bore with clean brake fluid before assembly, and that they avoid handling any of the parts with greasy or oily hands to prevent damage to the rubber parts.

Objective 11: Recognize types of automatic drum brake shoe adjusters by labeling illustrations with the correct names.

- Show students examples of manual and automatic adjusters.

- Display all types of automatic adjusting assemblies and have students identify each.

- Explain that some automatic adjustment systems operate only when braking in reverse, others when braking in a forward direction, others when using the parking brake, and still others when braking in either forward or reverse. If the actuating cable or link is attached to the anchor, adjustment takes place when braking in one direction only. If the actuating cable or link is attached to the brake shoe, adjustment takes place when braking in either direction.

- Illustrate your discussion of brake shoe adjusters with Transparencies 3 through 5 and Extensions and Options 2, Types of Import Drum Brakes, as applicable.

- Make it clear to the students that there are so many different types of adjusters and so many different ways to make manual and automatic brake adjustments that the specialist must *always* follow procedures outlined in the service manual for the make and model vehicle being serviced.

- Show students how adjuster components on some models are color coded.

- Caution students about interchanging parts from one side of the vehicle to the other or attempting to convert an old style star wheel or adjuster. As an example, explain that some star wheel adjusters on the right side of the vehicle may have right-hand threads and those on the left side may have left-hand threads. Interchanging these adjusters would cause the automatic adjusting levers to back off on the assemblies every time a stop is made in reverse, resulting in low brake pedal reserve.

APPLICATION

DIAGNOSIS SKILLS

Diagnosis is the highest level of competence in automotive service. Any type of automotive diagnosis requires that the technician possess both extensive knowledge and considerable practical skill. In this series, the Assignment Sheets are designed to help the student learn the diagnostic skills involved in using trouble-shooting procedures and diagnostic charts commonly found in vehicle service manuals. These skills are only part of the total requirement for diagnostic excellence.

We recognize that a good diagnosis cannot be made without the practical knowledge the student will learn from performing the Job Sheet tasks. At the same time, the Job Sheet procedures should not be performed unless the necessity for them is indicated by a proper diagnosis. You will need to analyze your teaching techniques and decide whether to have your students do the Assignment Sheets before the Job Sheets or vice versa. For students who are newly learning these skills, there are pitfalls to both sequences.

Objective 12: Diagnose drum brake problems. (Assignment Sheet)

- Have the students use Supplement 1, Troubleshooting Chart for Drum Brakes, and Supplement 2, Causes of Drum Brake Defects to help them complete the Assignment Sheet.

Objective 13: Remove, clean, and visually inspect brake drums. (Job Sheet 1)

- Provide students with copies of *Drum Brake Service Manual* (17D-11) and the Abex Corporation booklet, *Looking inside the Brake Drum*, to use as supplemental references.
- Review asbestos safety guidelines. Introduce students to the installation and use of the enclosure-type cleaner. Make sure that each student knows how to install and use this equipment.
- Show the filmstrip, *GM X-Body Brake Service*, and/or the video, *Remove, Inspect, and Replace Brake Drums*, from the series, *Service Drum Brakes*.

- Discuss the correct use of an inspection report form such as Extensions and Options 3, Brake System Inspection Report Form, or similar form and provide students with copies for them to use while practicing inspection procedures.
- Discuss the equipment and materials used in Job Sheet 1.
- Review the applicable safety rules and precautions with the students.
- Discuss the Job Sheet introduction.
- Demonstrate Job Sheet 1.
- Have the students practice Job Sheet 1 until they are ready to take the Practical Test.

Objective 14: Measure and refinish brake drums. (Job Sheet 2)

- Show the filmstrip, *Resurfacing a Brake Drum*, from the series, *The Brake Lathe*, to supplement your introduction of the drum brake lathe.
- Discuss the equipment and materials used in Job Sheet 2.
- Review the applicable safety rules and precautions with the students.
- Discuss the Job Sheet introduction.
- Demonstrate Job Sheet 2.
- Introduce students to the drum brake lathe and its accessories. Explain how the lathe can be adapted for disc brake machining. Have each student practice mounting a drum on the lathe and adjusting it for correct machining.
- Have the students practice Job Sheet 2 until they are ready to take the Practical Test.

Objective 15: Remove, clean, and inspect brake shoes and related hardware. (Job Sheet 3)

- Show the video, *Remove and Replace Brake Shoes*, from the series, *Service Drum Brakes*.

- Discuss the equipment and materials used in Job Sheet 3.
- Review the applicable safety rules and precautions with the students.
- Discuss the Job Sheet introduction.
- Demonstrate Job Sheet 3.
- Have the students practice Job Sheet 3 until they are ready to take the Practical Test.

Objective 16: Remove, recondition, and reinstall a wheel cylinder. (Job Sheet 4)

- Show the video, *Remove, Repair, and Replace Wheel Cylinders*, from the series, *Service Drum Brakes*.
- Discuss the equipment and materials used in Job Sheet 4.
- Review the applicable safety rules and precautions with the students.
- Discuss the Job Sheet introduction.
- Demonstrate Job Sheet 4.
- Have the students practice Job Sheet 4 until they are ready to take the Practical Test.

Objective 17: Adjust brake shoes and reinstall shoes, related hardware, and drums or drum/hub assemblies. (Job Sheet 5)

- Show the videos, *Adjust Brake Shoes*, *Hydraulic Brake Service: Removing Drum-Type Brake Linings*, and *Installing Drum-Type Brake Linings*, from the series, *Service Drum Brakes*.
- Discuss the equipment and materials used in Job Sheet 5.
- Review the applicable safety rules and precautions with the students.
- Discuss the Job Sheet introduction.
- Demonstrate Job Sheet 5.

- Have the students practice Job Sheet 5 until they are ready to take the Practical Test.

Objective 18: Adjust an integral parking brake. (Job Sheet 6)

- Discuss the equipment and materials used in Job Sheet 6.
- Review the applicable safety rules and precautions with the students.
- Discuss the Job Sheet introduction.
- Demonstrate Job Sheet 6.
- Have the students practice Job Sheet 6 until they are ready to take the Practical Test.

EVALUATION

- Give the Written Test.

  NOTE: The Written Test may be given in sections if desired.

- Many multiple-choice test questions (in the Activity Sheets, Assignment Sheets, and Written Test) for this curriculum have been written in a style that is similar to the questions on the ASE certification test. Like ASE questions, the student should select the item that **BEST** answers the question. *The student should make no additional assumptions about a question other than those specifically given int he question.* A special effort has been made to provide good distracters for each question which will make the student think through the answer. It is suggested that the instructor review the answers to every test before reviewing the test with the students so that he or she is not caught off guard by such distracters.
- Evaluate the class on the Assignment Sheet activities if not previously done.
- Give the Practical Tests, providing students with copies of Extensions and Options 3, Brake System Inspection Report Form, or similar form to be completed as part of the Practical Tests.
- Reteach and retest as required.

- The Activity Sheets may be given at the end of the unit as a review and a preview of the ASE test style.
- Complete the appropriate section of the Competency Profiles.
- Review individual and group performance in order to evaluate teaching methods.
- Adjust the scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Resources used in developing unit

- *Automotive Brake Service, Unit 1: Brake Inspection and Diagnosis.* Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service.* Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Bendix Service Manual 8-400: Domestic and Import Car Brake Service Manual.* Jackson, Tennessee: Bendix Aftermarket Brake Division, n.d.
- *Introduction to Automotive Mechanics, Unit 2: Lubrication, Cooling, and Safety Inspection Services.* Tallahassee, Florida: Florida Department of Education, 1986.
- Billiet, Walter E., And Walter Alley. *Automotive Suspensions, Steering, Alignment, and Brakes*, 5th ed. Alsip, Illinois: American Technical Publishers, Inc., 1982.
- *Chilton's Auto Repair Manual 1985: Domestic and Canadian Cars from 1978 through 1985.* Radnor, Pennsylvania: Chilton Book Company, 1984.
- Coghlan, David A. *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed. Boston: Breton Publishers, A Division of Wadsworth, Inc., 1985.
- Crouse, William H., and Donald L. Anglin. *Automotive Mechanics*, 9th ed. New York: Gregg Division, McGraw-Hill Book Company, 1985.

- Henderson, Chuck, and Ivan Armstrong. *Auto Mechanics I.* Stillwater, Oklahoma: Oklahoma Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1976.

- Hughes, James G. *Guide to Automobile Certification Examination*, Revised ed. Reston, Virginia: Reston Publishing Company, Inc., a Prentice-Hall Company, 1983.

- *Mitchell Chassis Service & Repair Domestic Cars: 1985 Supplement.* San Diego, California: Mitchell Information Services, Inc., a Cordura Company, 1985.

- *1986 New Model Highlights and Service Features: Domestic and Import.* Centerline, Michigan: Chrysler Corporation Service and Parts Operations, Training Program Development Department, 1985.

- *1986 Chrysler Engine-Chassis-Body Service Manual: 1986 Front Wheel Drive Passenger Vehicles Lancer, Daytona, New Yorker, Dodge 600, Aries, Omni, LeBaron GTS, LeBaron, Caravelle, Reliant, Horizon.* Centerline, Michigan: Chrysler Corporation, 1985.

- *1986 Shop Manual: Caprice, Monte Carlo, El Camino.* Detroit, Michigan: General Motors Corporation, Chevrolet Motor Division, 1986.

- *Raybestos Brake Service Manual for Passenger Cars: Drum and Disc Brakes.* Bridgeport, Connecticut: Division of Raybestos, Manhattan, 1970.

- Remling, John. *Brakes*, 2nd ed. New York: John Wiley and Sons, Inc., 1978.

- Stockel, Martin W., and Martin T. Stockel. *Auto Mechanics Fundamentals.* South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1982.

- Toboldt, William K., and Larry Johnson. *Automotive Encyclopedia: Fundamental Principles, Operation, Construction, Service, Repair.* South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1983.

- *Wagner Manual AU-1600/Feb., 1984: Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual.* Parsippany, New Jersey: Wagner Division, McGraw-Edison Company, 1984.

- *Wagner Manual AU-1600: Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual.* Parsippany, New Jersey: Wagner Division, Cooper Industries, Inc., 1988.

Media

Spelling and definitions of terminology used in automotive service are not standardized. Media selected to supplement and reinforce materials taught in this book may or may not use the same spelling and definitions. Although such deviations should not restrict classroom use of supplemental materials, its existence may confuse some students.

- *The Hydraulic Brake System Explained.* This series of six VHS cassettes (7 to 14 minutes each) and study guide contains a video on "How to Reline Drum-Type Brakes" and one titled "Servicing the Hydraulic System—Drum Type." It is available from National Innovative Media Company (NIMCO), Route #2, Box 301 B, Calhoun, Kentucky 42327, phone toll-free 800-962-6662.

- *Hydraulic Brake Service.* This series of six sound filmstrips contains filmstrips on "Removing Drum-Type Brake Linings" and "Installing Drum-Type Brake Linings."

- *The Brake Lathe.* This program of sound filmstrips includes a filmstrip on "Resurfacing a Brake Drum."

- *Brakes: Principles and Components.* This series of sound filmstrips and slides includes media on drum brakes and wheel cylinders.

- *GM X-Body Brake Service.* In this series, the Chevrolet Citation is used to introduce students to drum brake removal and reassembly.

  NOTE: These first five items are available from Vocational Media Associates, Prentice Hall Media, P.O. Box 1050, Mount Kisco, New York 10549-9989. Phone toll-free 800-431-2266. All of these media are available in their entirety for a full 30-day preview with no obligation.

- *Drum Brake Service.* Color filmstrip and cassette, available from Career Aids, Incorporated, 20417 Nordhoff Street, Department R., Chatsworth, California 91311, phone 818-341-8200.

- *Drum Brake Service and Drum Lathe Operation.* These two filmstrips and cassettes are available from Teaching Aids Incorporated, P.O. Box 1798, Costa Mesa, California 92628-0798, phone 714-548-9321.

- *Service Drum Brakes* containing the following: "Remove, Inspect, and Replace Brake Drums"; "Remove and Replace Brake Shoes"; "Remove, Repair, and Replace Wheel Cylinders"; and "Adjust Brake Shoes." These videotapes cover procedures outlined in the job sheets. Available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

Print Media

- *Brake System Schematic.* Available from Bendix Automotive Aftermarket, 1094 Bendix Drive, Jackson, Tennessee 38301.

- *Drum Brake Service Manual* (17D-11). Available free upon request from AC-Delco, General Motors Corporation, 400 Renaissance Center, Detroit, Michigan 48243.

- *Lee Import Drum Brake Assemblies Wall Chart.* This 18" x 23" chart is available from Lee Manufacturing Company, Division of Rolero, Inc., 4933 East 15th Street, Cleveland, Ohio 44128.

- *Looking Inside the Brake Drum.* Booklet covering numerous subjects, including lining installation, inspection of brake hardware, drum machining, and lining performance. Available free from Abex Corporation, Friction Products Division, 3001 West Big Beaver Road, Suite 710, Troy, Michigan 48084.

- Raybestos *Pit Stop for a Brake Clinic.* This booklet and film (Form #3815—Complete Kit) comprise a vocational school training program consisting of films, brochures, and a quiz patterned after the brake portion of the ASE Mechanic Certification Test. Available from Raymark Corporation, Aftermarket Division, 100 Overview Drive, Trumbull, Connecticut 06611.

- *Technical Bulletins*. Troubleshooting tips for current brake system and new brake system designs. Bulletins cover both domestic and import vehicles. Available from Autoline, 840 West 31st Street, Chicago, Illinois 60608.

- Competency Profiles.

  NOTE: Competency Profiles for this book are available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

CHARACTERISTICS OF GOOD BRAKE LININGS

Are resistant to heat fade — Are able to maintain effectiveness at high temperatures

Recover quickly — Are able to return rapidly to their pre-fade friction level under cooling conditions

Have good speed sensitivity — Are able to maintain effectiveness against drum surface at varying speeds

Are resistant to fade — Are able to give maximum performance and long wear without damaging drum surface

Have operating stability — Have suitable wear life in the anticipated range of brake heat

Operate quietly — Provide nearly noiseless, odor-free operation

Are of quality manufacture — Are made of quality ingredients that are properly cured

EXAMPLES:

Competitive — Flexible low-priced linings bonded to shoe; contain large amounts of fillers and low-quality asbestos; are cured in rolls rather than individually, and curing time is brief

Standard — Semirigid medium-priced linings to which wire backings are sometimes added for support; are riveted or bonded to shoe, and contain ingredients of average quality

Premium — Highest-priced linings, fully cured in rigid segments and containing the finest ingredients

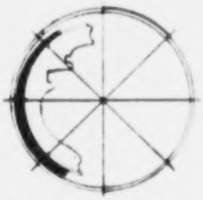
NOTE: Premium linings have a longer life than competitive or standard linings, withstand higher temperatures, and provide a higher resistance to fade.

Are shaped appropriately for application— Are correctly shaped for servo or non-servo brake action and for proper wearing in to match the drum

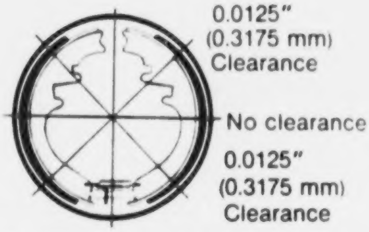
May be photocopied for student use.

BRAKE SHOE GRINDS

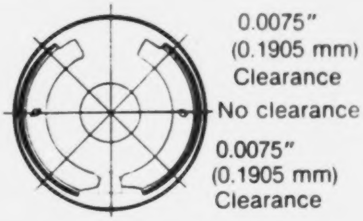
Modern brake shoes are usually supplied in what is known as a *cam, offset, contour,* or *eccentric* shape that is ground at the factory. That is, the fullest thickness of the lining is at the middle of the shoe, but the shoe is ground down slightly at the heel and toe. The diameter of the circle the shoes make is slightly smaller than that of the drum. This compensates for the minor tolerance variations of drums, brake mountings, etc., and promotes proper wearing in the linings to match the drums. See illustrations below.



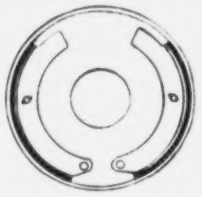
OEM offset grind
furnished on new vehicles


0.0125"
(0.3175 mm)
Clearance
No clearance
0.0125"
(0.3175 mm)
Clearance

Contour (eccentric) grind, servo


0.0075"
(0.1905 mm)
Clearance
No clearance
0.0075"
(0.1905 mm)
Clearance

Contour (eccentric)
grind, non-servo



Concentric grind

Since most automotive shoes are manufactured this way, the once common practice of arcing the shoes in the shop to match the drums has become unnecessary; thus, the health danger of working with asbestos dust during this procedure is avoided.

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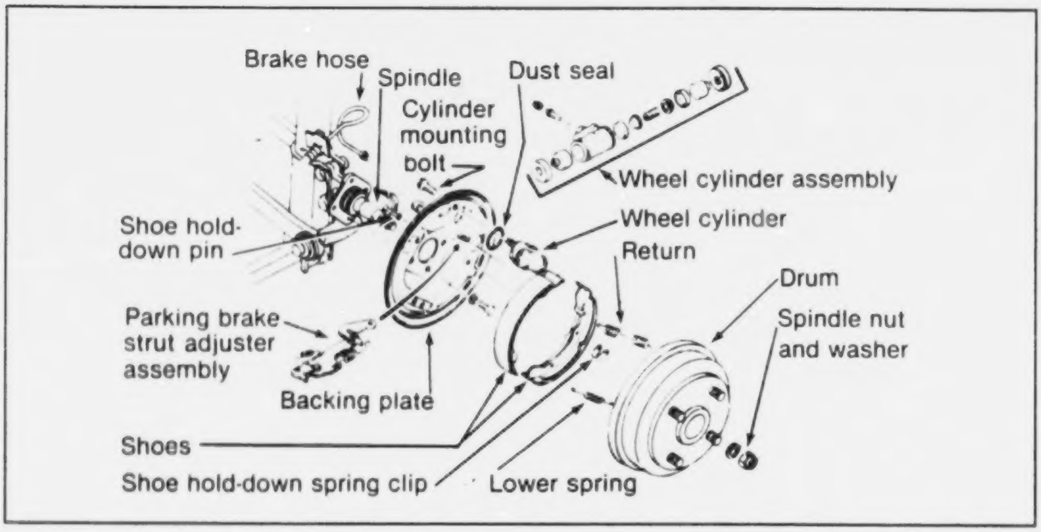
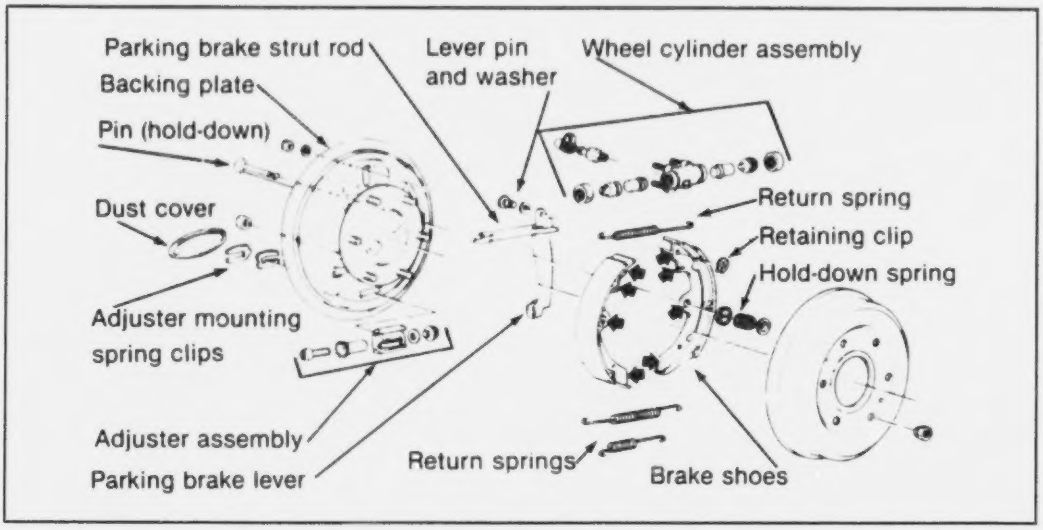
May be photocopied for student use

TYPES OF IMPORT DRUM BRAKES

- **Japanese drum with ratchet adjuster**

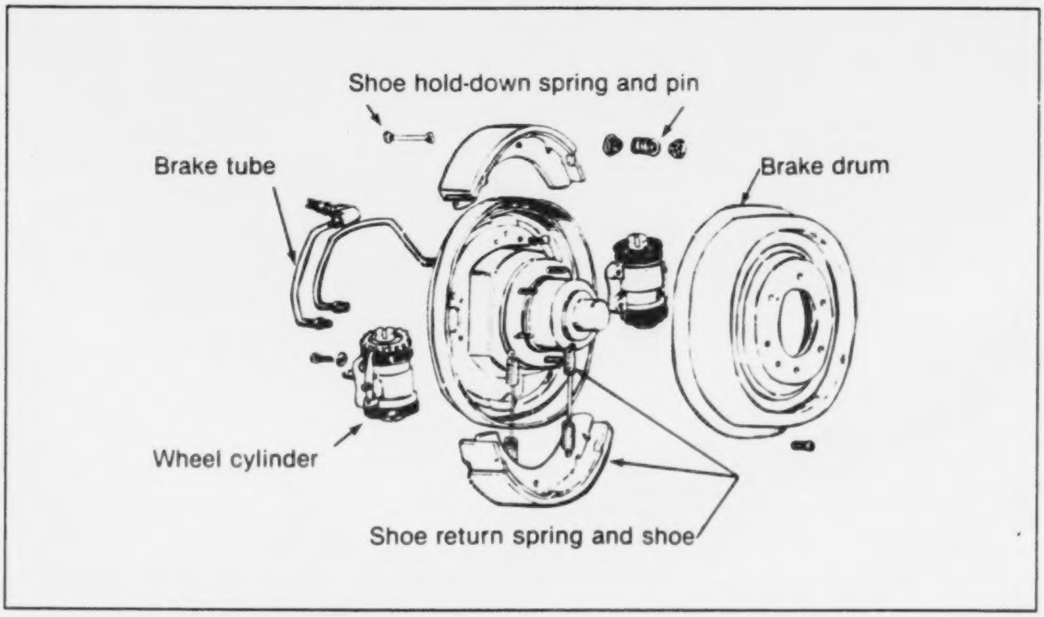

Brake hose
Spindle
Dust seal
Cylinder mounting bolt
Wheel cylinder assembly
Wheel cylinder
Shoe hold-down pin
Return
Drum
Spindle nut and washer
Parking brake strut adjuster assembly
Backing plate
Shoes
Shoe hold-down spring clip
Lower spring

- **Nissan drum with dual star wheel adjuster**

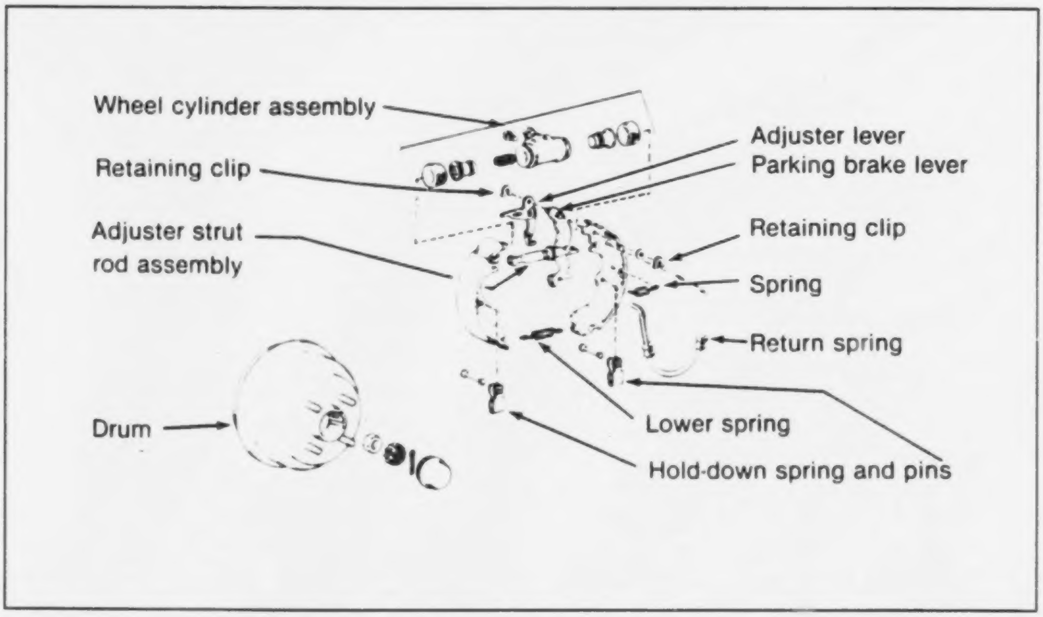

Parking brake strut rod
Lever pin and washer
Wheel cylinder assembly
Backing plate
Pin (hold-down)
Dust cover
Return spring
Retaining clip
Hold-down spring
Adjuster mounting spring clips
Adjuster assembly
Parking brake lever
Return springs
Brake shoes

May be photocopied for student use.

- **Dual wheel cylinder drum**

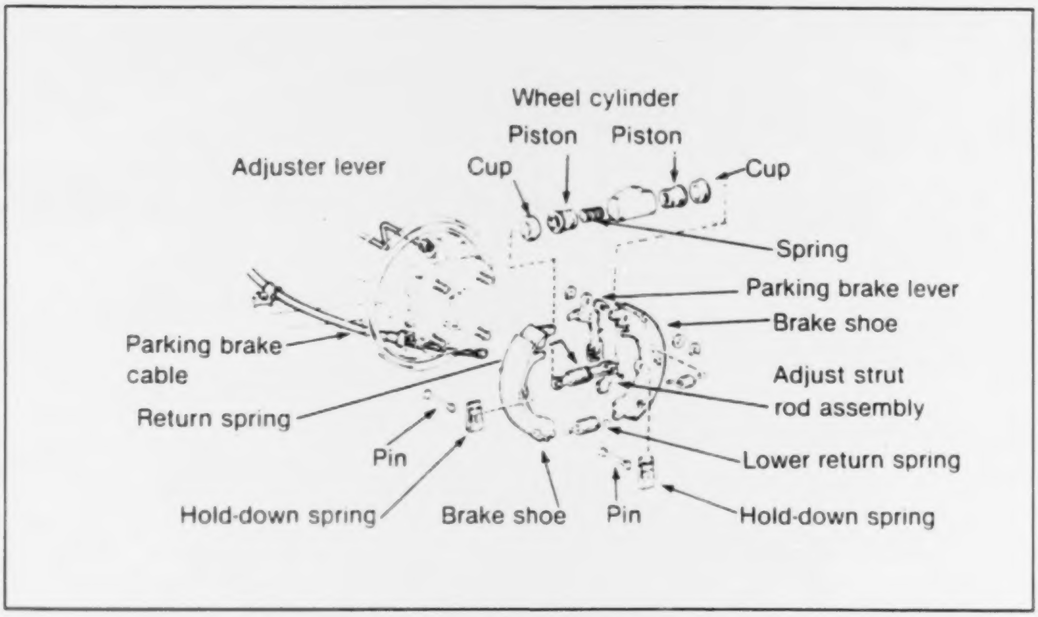

Shoe hold-down spring and pin
Brake tube
Brake drum
Wheel cylinder
Shoe return spring and shoe

- **Drum with U-type return spring**


Wheel cylinder assembly
Retaining clip
Adjuster strut rod assembly
Adjuster lever
Parking brake lever
Retaining clip
Spring
Return spring
Drum
Lower spring
Hold-down spring and pins

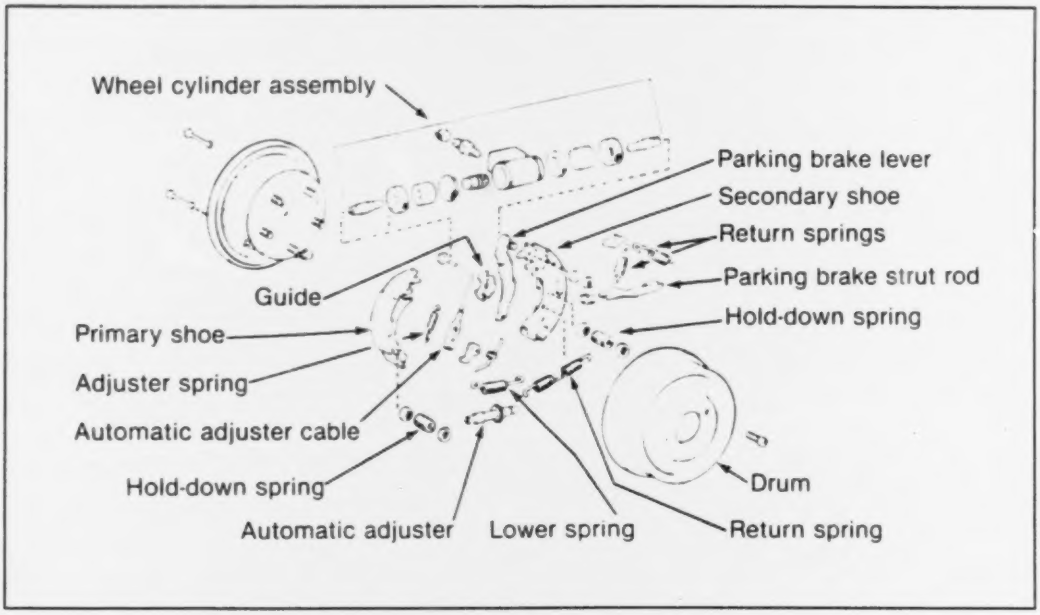
May be photocopied for student use.

- **Toyota with star wheel adjuster**



Wheel cylinder
Piston
Piston
Adjuster lever
Cup
Cup
Spring
Parking brake lever
Brake shoe
Parking brake cable
Adjust strut rod assembly
Return spring
Lower return spring
Pin
Hold-down spring
Brake shoe
Pin
Hold-down spring

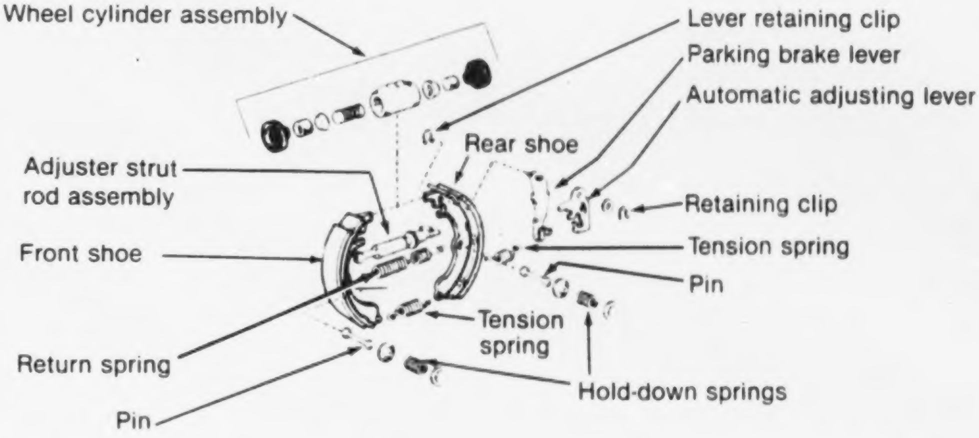
- **Japanese, Chrysler drum with cable automatic adjuster**



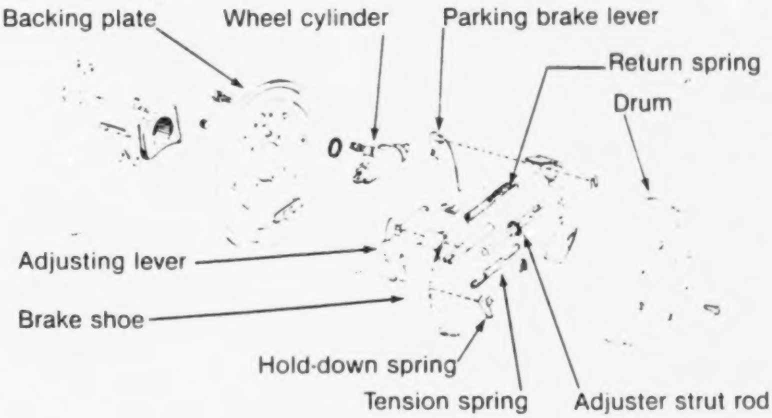
Wheel cylinder assembly
Parking brake lever
Secondary shoe
Return springs
Parking brake strut rod
Guide
Hold-down spring
Primary shoe
Adjuster spring
Automatic adjuster cable
Drum
Hold-down spring
Automatic adjuster
Lower spring
Return spring

May be photocopied for student use.

- **Toyota drum with lever automatic adjuster**

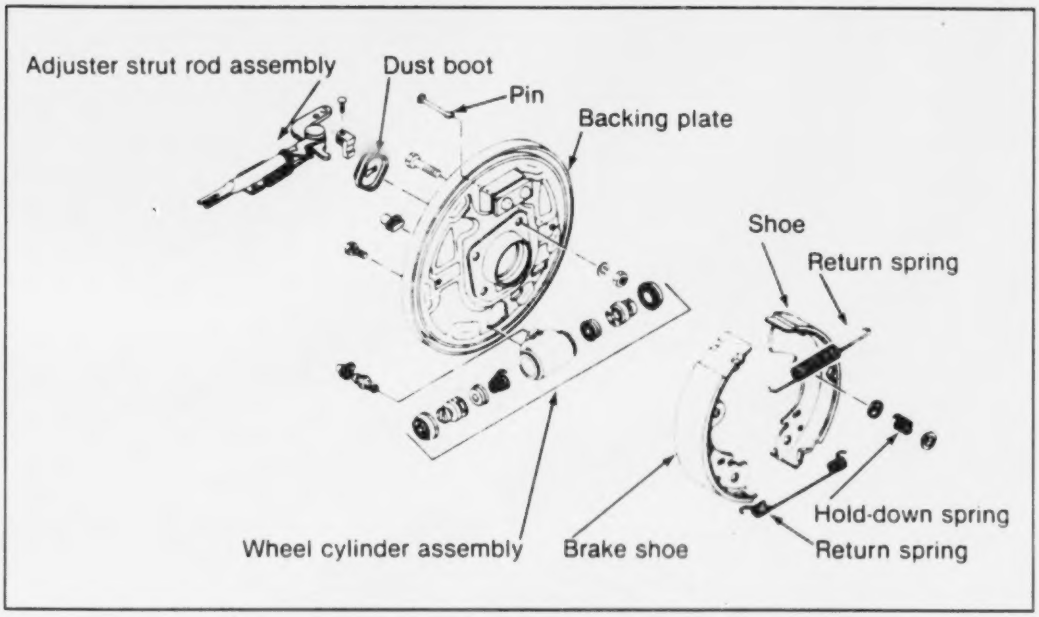

Wheel cylinder assembly
Lever retaining clip
Parking brake lever
Automatic adjusting lever
Rear shoe
Adjuster strut rod assembly
Retaining clip
Tension spring
Front shoe
Pin
Tension spring
Return spring
Hold-down springs
Pin

- **Mazda, Volkswagen with star wheel adjuster**

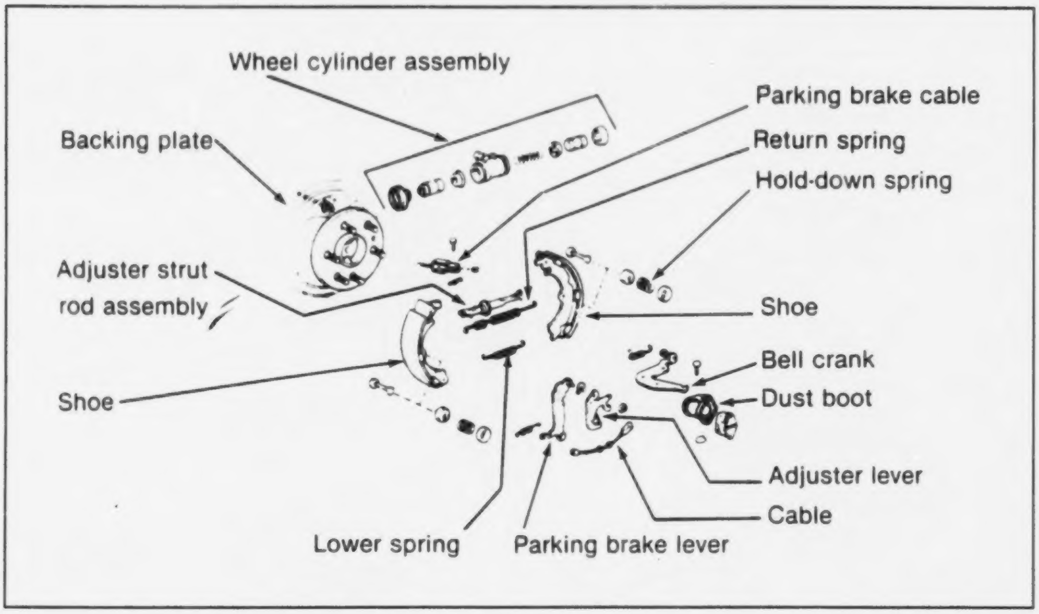

Backing plate
Wheel cylinder
Parking brake lever
Return spring
Drum
Adjusting lever
Brake shoe
Hold-down spring
Tension spring
Adjuster strut rod

May be photocopied for student use.

- **Nissan with strut rod adjuster**

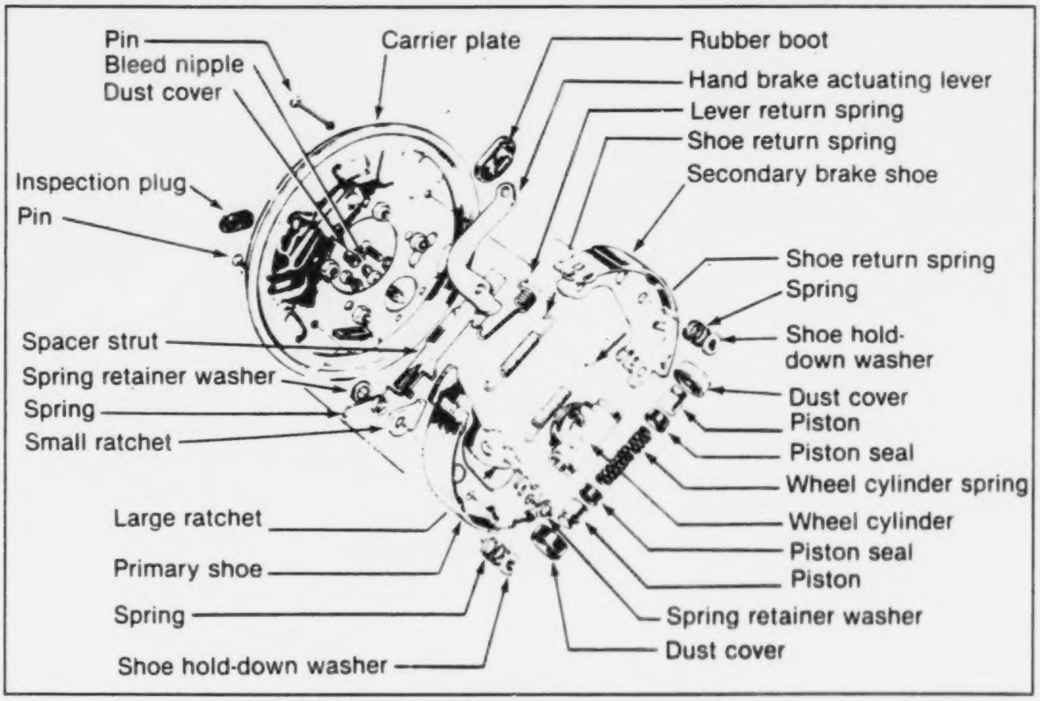

Adjuster strut rod assembly
Dust boot
Pin
Backing plate
Shoe
Return spring
Hold-down spring
Return spring
Wheel cylinder assembly
Brake shoe

- **Toyota rear drum with cable automatic adjuster**

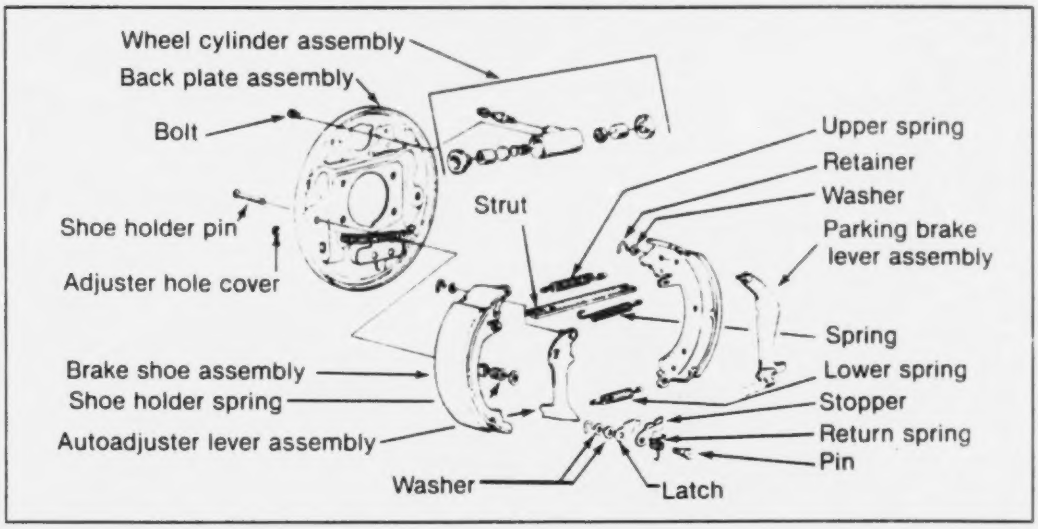

Wheel cylinder assembly
Parking brake cable
Backing plate
Return spring
Hold-down spring
Adjuster strut rod assembly
Shoe
Shoe
Bell crank
Dust boot
Adjuster lever
Cable
Lower spring
Parking brake lever

May be photocopied for student use.

- **Fiesta rear drum with ratchet adjuster**

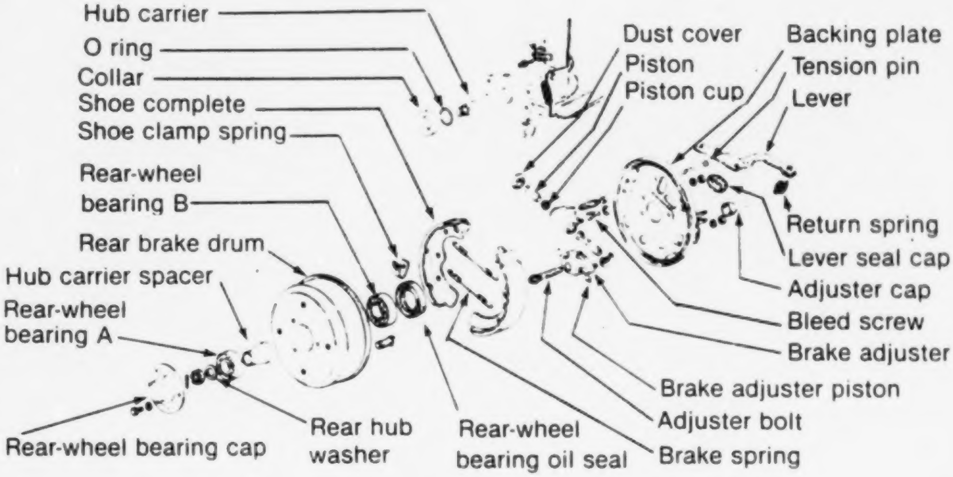

Pin
Bleed nipple
Dust cover
Carrier plate
Rubber boot
Hand brake actuating lever
Lever return spring
Shoe return spring
Secondary brake shoe
Inspection plug
Pin
Shoe return spring
Spring
Shoe hold-down washer
Spacer strut
Spring retainer washer
Dust cover
Spring
Piston
Small ratchet
Piston seal
Wheel cylinder spring
Large ratchet
Wheel cylinder
Piston seal
Primary shoe
Piston
Spring
Spring retainer washer
Dust cover
Shoe hold-down washer

- **Rear drum with ratchet adjuster**

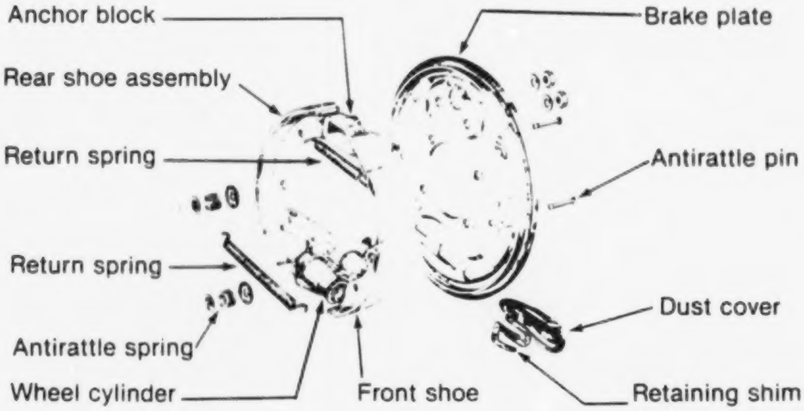

Wheel cylinder assembly
Back plate assembly
Bolt
Upper spring
Retainer
Washer
Strut
Shoe holder pin
Parking brake lever assembly
Adjuster hole cover
Spring
Brake shoe assembly
Lower spring
Shoe holder spring
Stopper
Autoadjuster lever assembly
Return spring
Pin
Washer
Latch

May be photocopied for student use

- **Rear drum with wedge (tapered) adjuster**

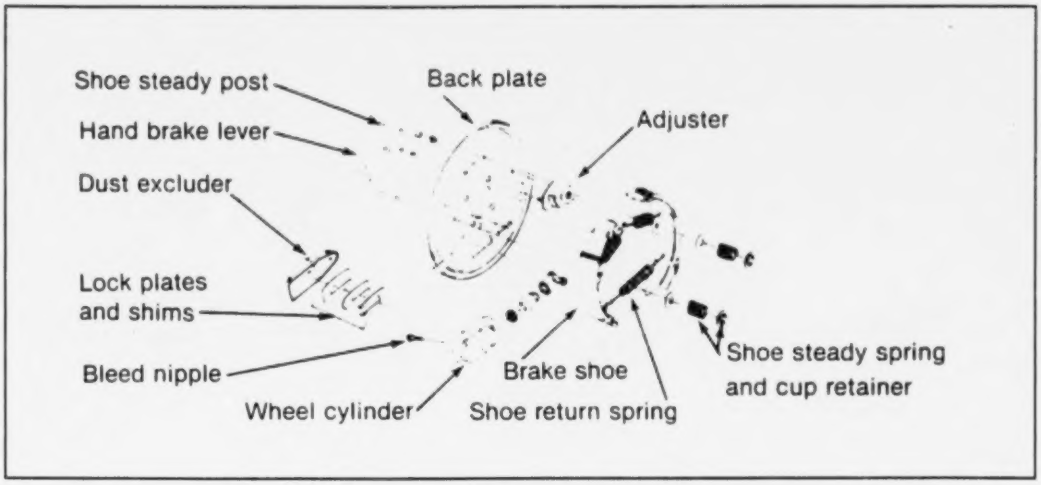

Hub carrier
O ring
Collar
Shoe complete
Shoe clamp spring
Rear-wheel bearing B
Rear brake drum
Hub carrier spacer
Rear-wheel bearing A
Rear-wheel bearing cap
Rear hub washer
Rear-wheel bearing oil seal
Dust cover
Piston
Piston cup
Backing plate
Tension pin
Lever
Return spring
Lever seal cap
Adjuster cap
Bleed screw
Brake adjuster
Brake adjuster piston
Adjuster bolt
Brake spring

- **Nissan rear drum (adjustment maintained by parking brake operation)**

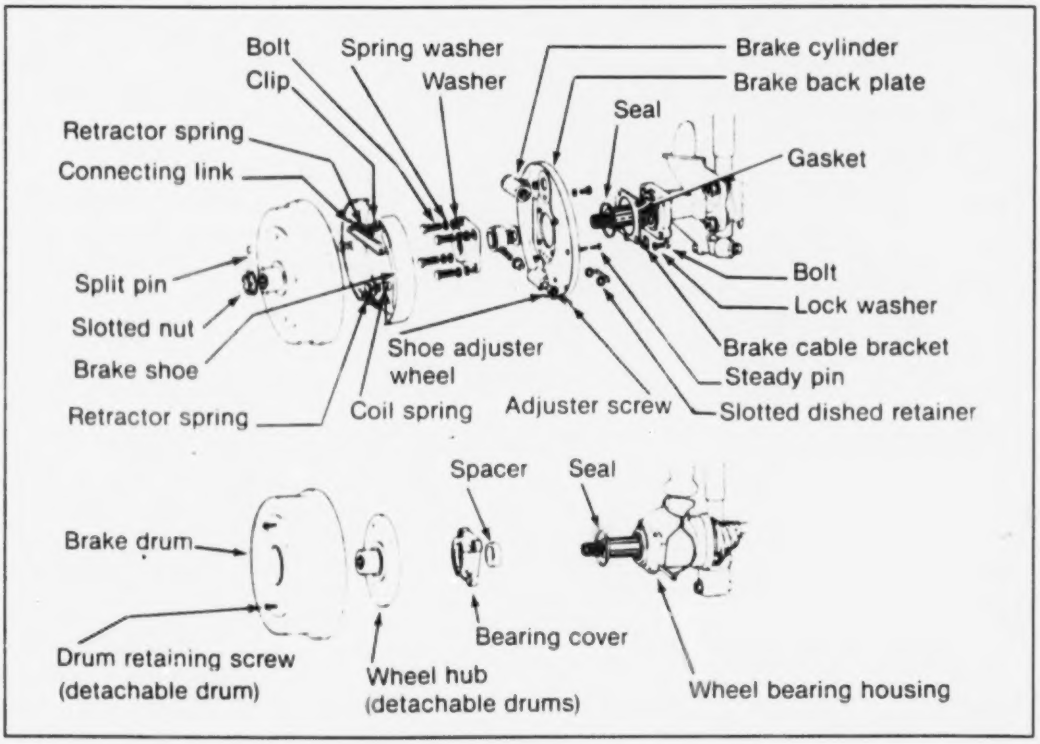

Anchor block
Rear shoe assembly
Return spring
Return spring
Antirattle spring
Wheel cylinder
Front shoe
Brake plate
Antirattle pin
Dust cover
Retaining shim

May be photocopied for student use.

- **Rear drum with single-piston wheel cylinder (moving)**

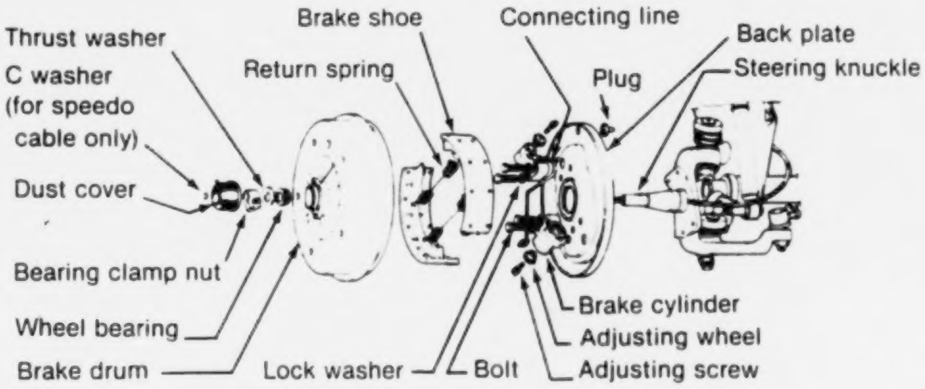

Shoe steady post
Back plate
Hand brake lever
Adjuster
Dust excluder
Lock plates and shims
Bleed nipple
Brake shoe
Shoe steady spring and cup retainer
Wheel cylinder
Shoe return spring

- **Volkswagen with dual star wheel adjuster**


Bolt
Spring washer
Brake cylinder
Clip
Washer
Brake back plate
Seal
Retractor spring
Gasket
Connecting link
Bolt
Lock washer
Split pin
Slotted nut
Brake cable bracket
Brake shoe
Shoe adjuster wheel
Steady pin
Retractor spring
Coil spring
Adjuster screw
Slotted dished retainer
Spacer
Seal
Brake drum
Bearing cover
Drum retaining screw (detachable drum)
Wheel hub (detachable drums)
Wheel bearing housing

May be photocopied for student use.

- **Dual cylinder drum**


Thrust washer
C washer (for speedo cable only)
Dust cover
Bearing clamp nut
Wheel bearing
Brake drum
Brake shoe
Return spring
Lock washer
Bolt
Connecting line
Plug
Back plate
Steering knuckle
Brake cylinder
Adjusting wheel
Adjusting screw

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BRAKE SYSTEM INSPECTION REPORT FORM

Customer name ______________________________

Address ____________ Telephone number: Work ____________ Home ____________

Vehicle make ____________ Year ____________ Mileage ____________

License number ______________________________

Approximate time required for service ______________________________

Inspected by ______________________________ Date ____________

The condition of the brake system on this vehicle is as follows:

Brake system components	**Required services**	**$ Estimate** Parts	Labor
Disc pads	☐Semi-metallic ☐Conventional		
Disc caliper	☐Recondition ☐Replace		
Disc hardware	☐Replace		
Disc rotor	☐Recondition ☐Replace		
Grease seals	☐Replace		
Front wheel bearings	☐Repack ☐Replace		
Wheel cylinders	☐Recondition ☐Replace		
Rear brake hardware	☐Replace		
Brake shoes	☐Replace		
Brake drums	☐Recondition ☐Replace		
Parking brakes	☐Adjust ☐Lubricate ☐Replace		
Power brake booster	☐Service ☐Replace		
Master cylinder	☐Recondition ☐Replace		
Brake fluid	☐Drain old, and add new fluid		
Lines, hoses, combination valve	☐Replace		
Stop light, warning light	☐Replace bulb ☐Replace switch ☐Adjust ☐Replace		
Other ____________			
	Total		

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OBJECTIVE 1

Recognize definitions of terms associated with drum brakes by choosing the correct definitions from lists of three choices.

dissipate — to break up and scatter; to disperse or make disappear

drum brake — brake design in which curved brake shoes press against inner circumference of a rotating metal drum to produce braking action

eccentric — disc or lobe (cam) used to convert rotary action to reciprocating action; off-center

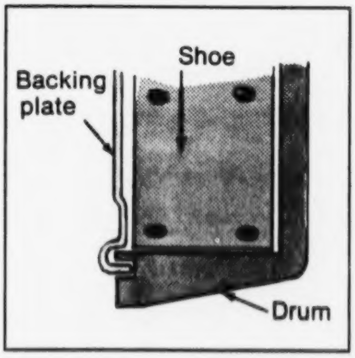
flange — projecting lip, rim, or edge

honing — removing metal with a fine abrasive stone

labyrinth seal — seal formed by backing plate flange and drum rim that prevents water splashed from the road from entering the brake mechanism (Figure 1)

EXAMPLE:

FIGURE 1



pawl — arm pivoted so that its free end can fit into a detent, slot, or groove to hold a part stationary

primary shoe — in servo brakes, that shoe toward front of forward-moving vehicle

NOTE: In non-servo brakes, this shoe called the *forward* or *leading* shoe.

recondition — to machine or return a part to its original surface condition

residual valve — device that maintains pressure in the system after brake pedal is released to prevent leakage at wheel cylinders

secondary shoe — in servo brakes, that shoe toward rear of forward-moving vehicle

NOTE: In non-servo brakes, this shoe is called the *reverse* or *trailing* brake shoe.

PRIMARY AND SECONDARY SHOES

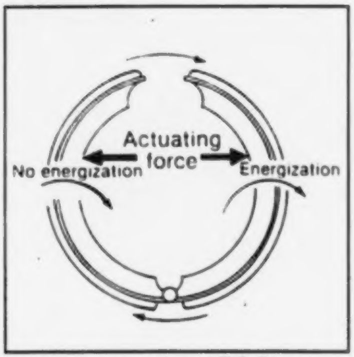
The chief difference between primary and secondary shoes is the location; however, depending on the manufacturer, length and width of the shoes may also be different. The secondary shoe, the rear shoe of the set, normally has a full-length lining, centered on the shoe. The primary shoe, the front shoe of the set, may be shorter and/or narrower than the secondary shoe, but not always. Many imported pickups use the same size shoe and lining, but the composition of the lining materials differs. Additionally, brake shoes located on the front wheels are usually wider than those on the rear wheel set. Finally, the diameter of the front set of brake shoes may be larger than that of the rear set of shoes—for example, 10-inch front brakes and 9-inch rear.

self-adjusting — process of compensating for shoe wear by automatically adjusting shoe-to-drum clearance

self-energizing — use of friction to force one brake shoe tighter against drum (Figure 2)

EXAMPLE:

FIGURE 2

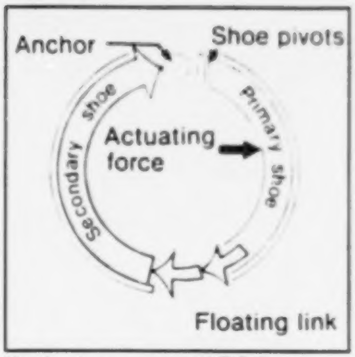


Used with permission of EIS Corp.

servo action — process that results when both shoes are free to swing into drum, and primary shoe helps apply secondary shoe (Figure 3)

EXAMPLE:

FIGURE 3


Anchor
Shoe pivots
Secondary shoe
Primary shoe
Actuating force
Floating link

Used with permission of EIS Corp.

OBJECTIVE 2

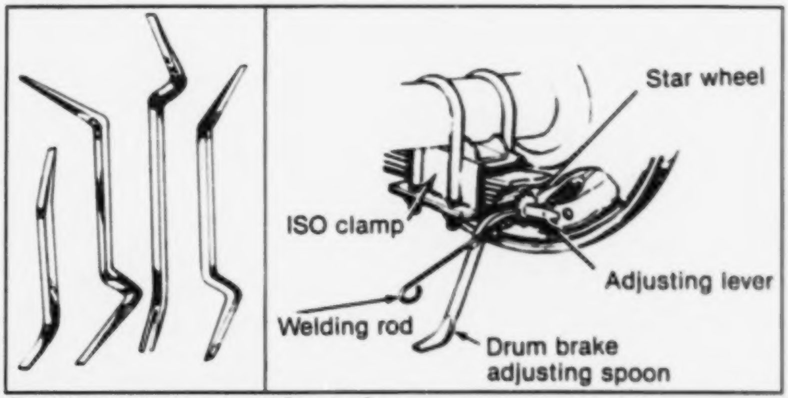
Recall uses of specialty tools used to service drum brakes by writing the correct use when given the name of a specialty tool.

Drum brake adjusting spoon — used to back off star wheel for drum removal or for adjustment of lining-to-drum clearance (See Figure 4)

NOTE: The tools shown in Figure 4 vary slightly for different makes and models of automobiles.

EXAMPLE:

FIGURE 4


Star wheel
ISO clamp
Adjusting lever
Welding rod
Drum brake adjusting spoon

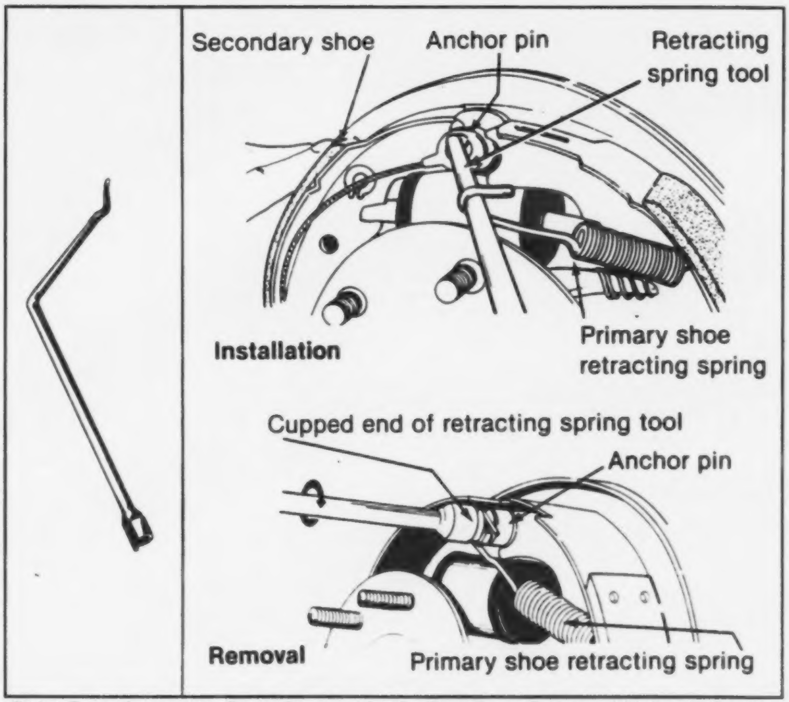
(Right) Used with permission of Chrysler Corp.

Retracting spring (brake spring) tool — used to pry springs off anchor pin for removal and to stretch springs over anchor pin for reinstallation (Figure 5)

NOTE: Note that each end of the tool is designed for a specific function. The pointed end is used for reinstallation of spring and the cupped end is used for removal.

EXAMPLE:

FIGURE 5


Secondary shoe
Anchor pin
Retracting spring tool
Installation
Primary shoe retracting spring
Cupped end of retracting spring tool
Anchor pin
Removal
Primary shoe retracting spring

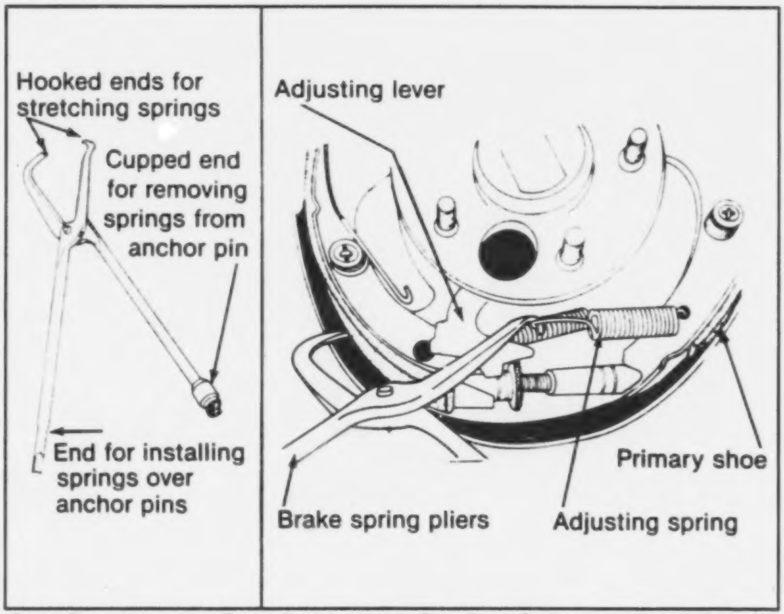
(Right) From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*, © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

Brake spring pliers — used to remove and reinstall retracting and adjusting springs (Figure 6)

NOTE: This tool is a variation of the retracting spring tool shown in Figure 5. Note that the end of one handle is adapted for removal and the other for reinstallation. The pliers have hooked ends that allow the technician to grasp and stretch the spring.

EXAMPLE:

FIGURE 6

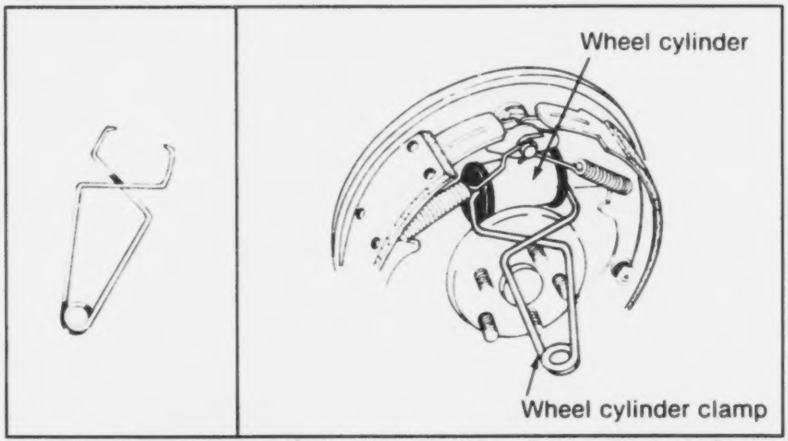

Hooked ends for stretching springs
Cupped end for removing springs from anchor pin
End for installing springs over anchor pins
Adjusting lever
Primary shoe
Brake spring pliers
Adjusting spring

(Right) From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service,* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

Wheel cylinder clamp — used to prevent hydraulic pressure from pushing wheel cylinder pistons and cups too far out in bore when brake shoe retracting springs are removed (Figure 7)

EXAMPLE:

FIGURE 7

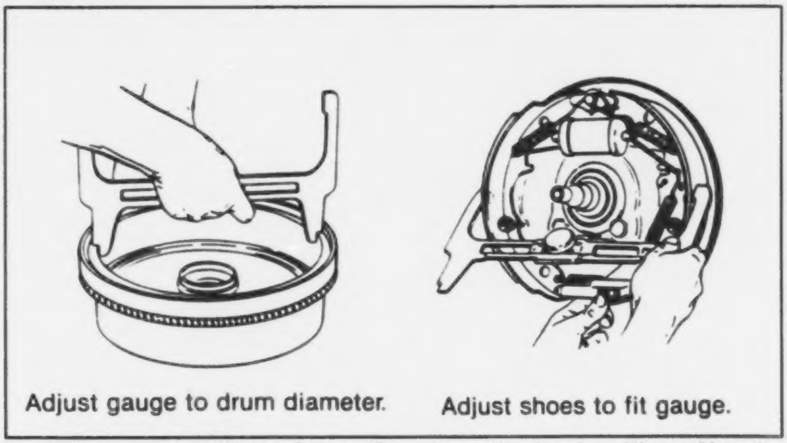


(Right) From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

Drum-to-shoe gauge — used to measure and adjust lining-to drum clearance (Figure 8)

EXAMPLE:

FIGURE 8



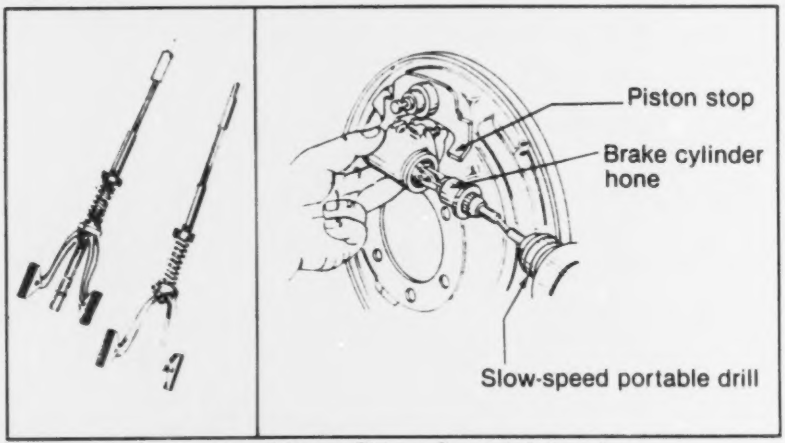
Adjust gauge to drum diameter. Adjust shoes to fit gauge.

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600*, copyright © 1988.

Brake cylinder hone — used to recondition wheel cylinder bore (Figure 9)

EXAMPLE:

FIGURE 9

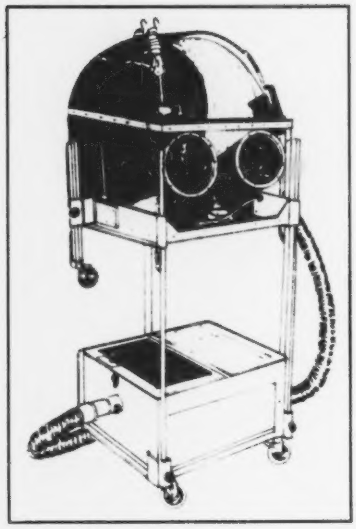

Piston stop
Brake cylinder hone
Slow-speed portable drill

(Right) Used with permission of Wagner Division, Cooper Industries, Inc.

Enclosure-type brake cleaner — used to clean brake lining dust from brake assembly; designed to protect technician from harmful asbestos fibers (Figure 10)

EXAMPLE:

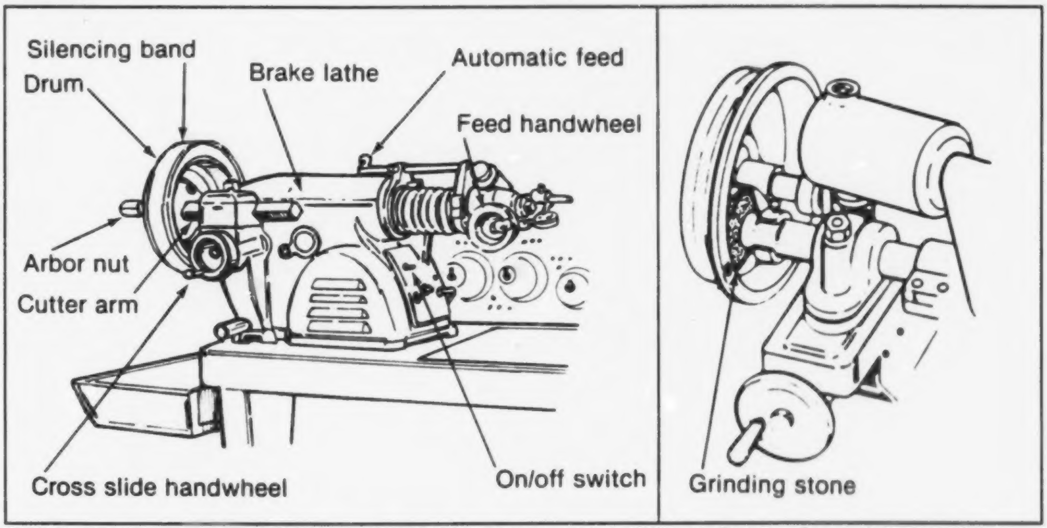
FIGURE 10



Drum brake lathe — used to machine the friction surface of brake drums (Figure 11)

EXAMPLE:

FIGURE 11

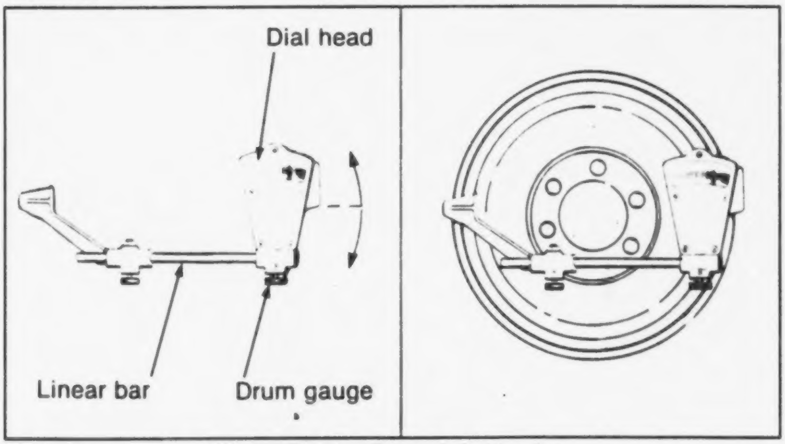

Silencing band
Drum
Brake lathe
Automatic feed
Feed handwheel
Arbor nut
Cutter arm
Cross slide handwheel
On/off switch
Grinding stone

(Left) Used with permission of EIS Corp. (Right) Used with permission of Wagner Division, Cooper Industries, Inc.

Brake drum micrometer — used to measure drum diameter (Figure 12)

EXAMPLE:

FIGURE 12


Dial head
Linear bar
Drum gauge

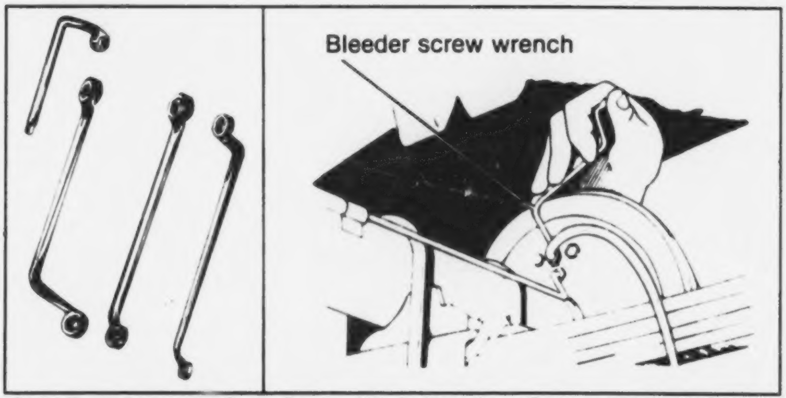
Used with permission of Wagner Division, Cooper Industries, Inc.

Bleeder screw wrench — used to open and close wheel cylinder bleeder screws (Figure 13)

NOTE: Note the design variations in the bleeder screw wrenches illustrated in Figure 13. One is a right-angle wrench, others have offset heads, and still others are designed for specific makes and models of automobiles.

EXAMPLE:

FIGURE 13

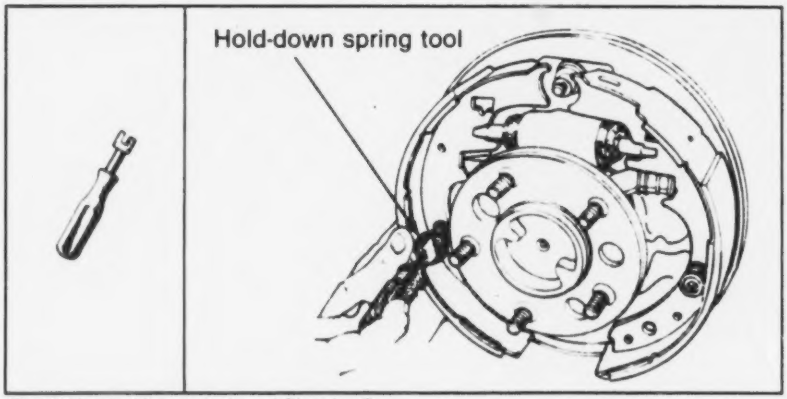


(Right) From *Automotive Brake Service, Unit 3: Rear Drum Brake and Hydraulic System Service*, © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

Hold-down spring tool — used to remove and reinstall hold-down springs (Figure 14)

EXAMPLE:

FIGURE 14



(Right) Used with permission of Chrysler Corp.

OBJECTIVE 3 **Recall steps in drum brake operation by listing the steps in correct sequence.**

1. Brake pedal is depressed, generating hydraulic pressure in master cylinder.

2. Hydraulic pressure from master cylinder is transmitted to wheel cylinder.

3. Wheel cylinder pistons push brake shoes against rotating drum.

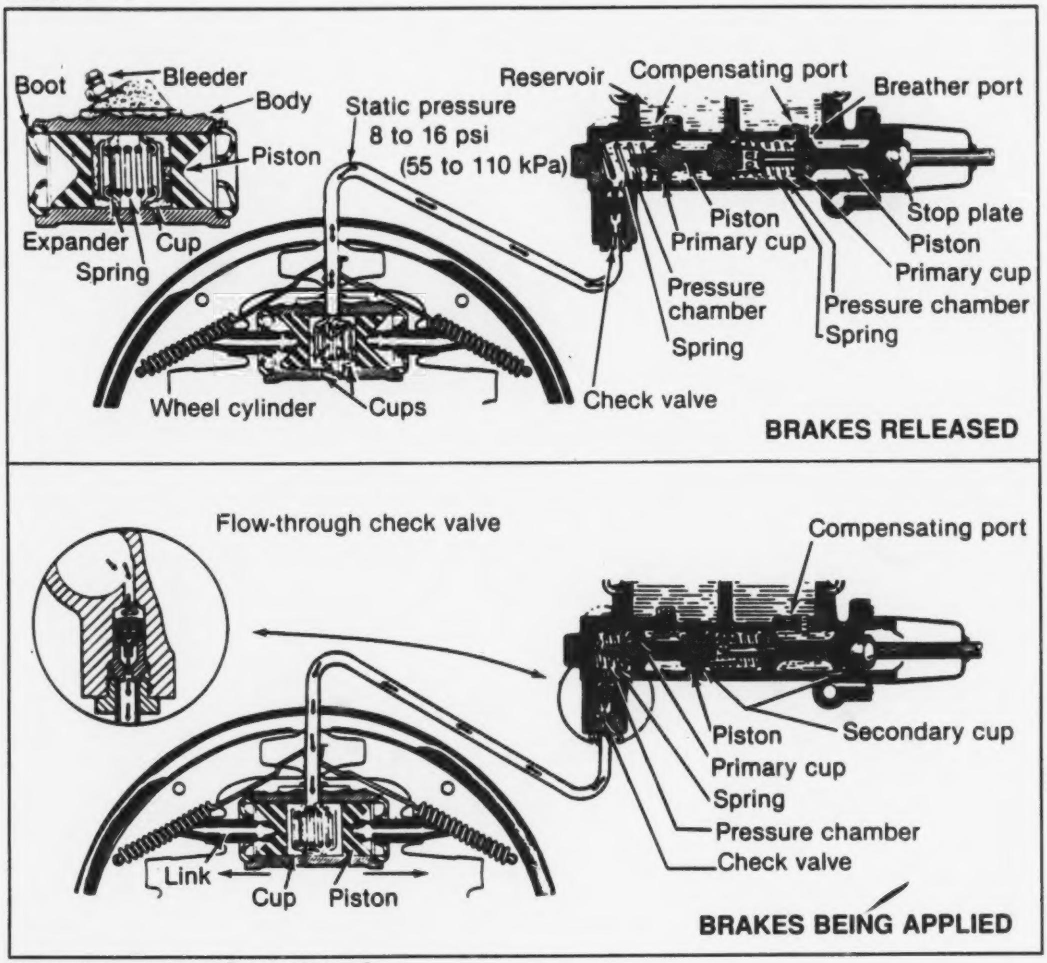
4. Shoes try to rotate with drum, producing a wedging action that helps press the linings into firmer contact with drum.

   NOTE: This self-energizing action supplements hydraulic effort, increasing friction and improving stopping ability.

5. Friction between brake shoe and brake drum slows or stops rotation of wheel.

EXAMPLE:

FIGURE 15

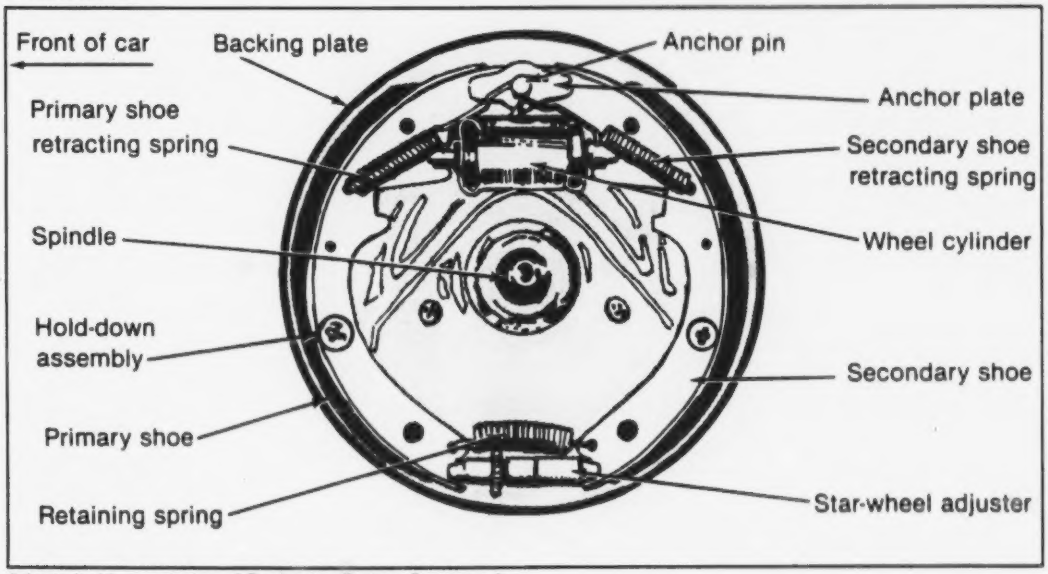

Boot
Bleeder
Body
Piston
Expander
Cup
Spring
Static pressure
8 to 16 psi
(55 to 110 kPa)
Reservoir
Compensating port
Breather port
Stop plate
Piston
Primary cup
Piston
Primary cup
Pressure chamber
Pressure chamber
Spring
Spring
Wheel cylinder
Cups
Check valve
BRAKES RELEASED
Flow-through check valve
Compensating port
Piston
Secondary cup
Primary cup
Spring
Pressure chamber
Check valve
Link
Cup
Piston
BRAKES BEING APPLIED

Used with permission of General Motors Corp.

OBJECTIVE 4 **Recall components of typical duo-servo and non-servo brake assemblies by labeling the components shown on an illustration.**

- **Duo-servo brake assembly**

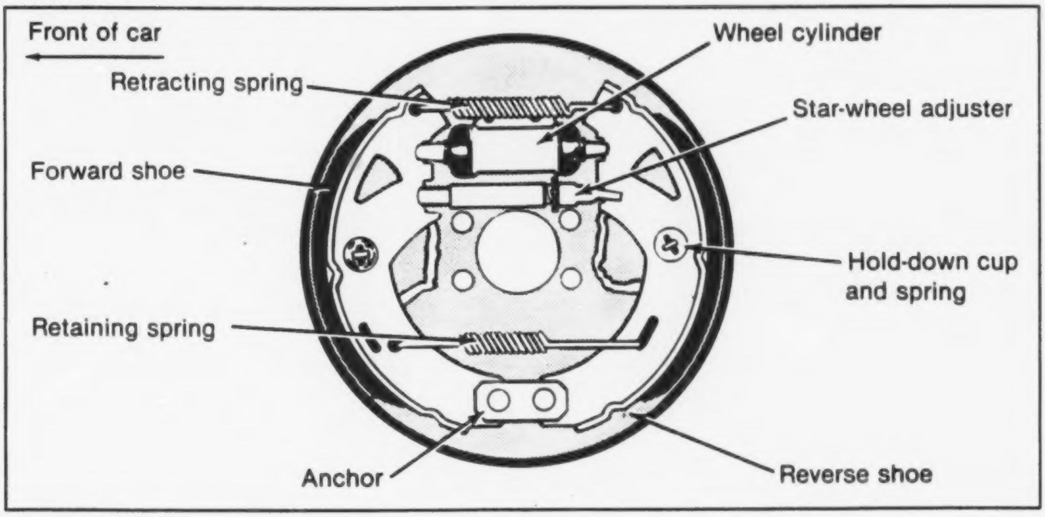
FIGURE 16


Front of car
Backing plate
Anchor pin
Anchor plate
Primary shoe retracting spring
Secondary shoe retracting spring
Wheel cylinder
Spindle
Hold-down assembly
Secondary shoe
Primary shoe
Retaining spring
Star-wheel adjuster

Adapted with permission of Raybestos/Brakes Systems, Inc.

- **Non-servo brake assembly**

FIGURE 17


Front of car
Wheel cylinder
Retracting spring
Star-wheel adjuster
Forward shoe
Hold-down cup and spring
Retaining spring
Anchor
Reverse shoe

OBJECTIVE 5

Recognize the functions of components of a duo-servo brake assembly by matching components to their correct functions.

anchor pin — prevents shoes from turning with the brake drum

backing plate — holds all of the brake parts except the drum

brake lining — contacts drum and provides friction necessary for braking action

brake shoe — provides mounting surface for lining

hold-down assembly — holds shoes flat against backing plate

retaining spring — holds shoes together at star wheel adjuster

retracting spring — pulls shoes away from drum when brakes are released

star wheel adjuster — pushes shoes farther apart as lining wears

wheel cylinder — pushes brake shoes out into contact with drum

SERVO ACTION

The servo brake design found on most vehicles contains two shoes, a *primary shoe* and a *secondary shoe*, which are held against the anchor pin until the wheel cylinder is pressurized. When the brakes are applied, the wheel cylinder pressure forces the tops of both shoes against the drum. Due to the rotation of the drum and the friction between the shoes and drum, the shoes rotate in the same direction. However, the secondary shoe cannot rotate because it is stopped by the anchor pin, but the primary shoe moves away from the anchor pin and transfers its force through the star wheel to the secondary shoe. Thus it "serves" the secondary shoe by pushing it against the drum with extra force. This action is called *servo* action.

When a vehicle is moving backward, the drum rotation is reversed and the function of the shoes is also reversed, the primary shoe being "served" by the secondary shoe. When servo action is provided in both directions, the brake is called *duo-servo.*

In non-servo brakes, each shoe is separately anchored at the bottom, and their action is not compounded. Because of this difference in operation, non-servo brake shoes are called *forward* or *leading* shoes and *reverse* or *trailing* shoes. The leading shoe is self-energized by the usual drum rotation, and the reverse shoe is deenergized. The self-energizing action is reversed when the drum is rotated backwards.

OBJECTIVE 6

Recognize definitions of terms associated with brake drum problems by matching terms to their correct definitions.

carbonizing — severe overheating of an object resulting in a change of the material content

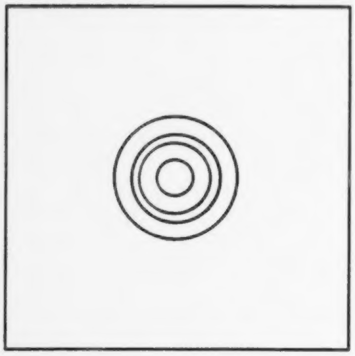
NOTE: This process is called *carbonizing* because the material left is usually a carbon material such as ash or carbon scorching.

concave — curved inward

concentric — having a common center (Figure 18)

EXAMPLE:

FIGURE 18



convex — curved outward

deflection — turned or bent to one side

distorted — twisted out of shape or changed from usual or normal shape

eccentric — not having a common center; out-of-round

fade — loss of braking friction caused by excessive heat

galling — forcing material out of its regular shape or condition by high-pressure rubbing

glazed — having shiny, glass-hard resin deposits on surface

wallowed — having enlarged misshapen hole due to wear or rubbing

warpage — condition of no longer being perfectly round or true

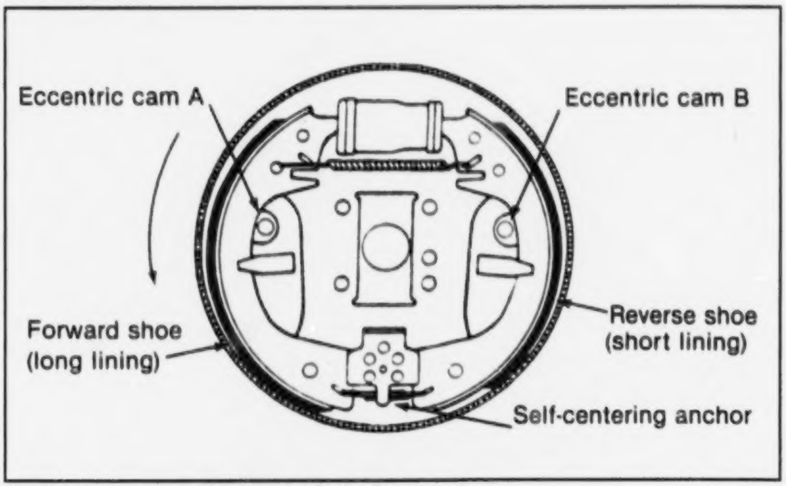
OBJECTIVE 7 **Recall defects to look for when visually inspecting drum brake components by listing defects for given component names.**

COMPONENT	DEFECTS
Brake lining	• Cracks • Glazing • Fluid or grease contamination • Uneven wear
Drum	• Hot spots • Scoring • Cracking • Out-of-round • Oversize
Backing plates	• Cracks and warpage • Pads for ridges • Pads for steps • Lack of lubrication
Shoe retainer and spring nail assemblies	• Wallowing of retainer holes • Loose springs • Improper installation of spring nails or retainers
Retaining springs	• Overheating • Stretching • Distortion • Nicks
Automatic adjuster assemblies	• Missing or damaged parts • Improper installation • Frayed adjusting cables • Rounded-off star wheels • Damaged cable guides • Damaged adjusting levers • Frozen adjusting screws

OBJECTIVE 8 **Recall common types of brake shoe mountings by writing the correct names for given illustrations.**

- **Single-anchor self-centering**

FIGURE 19

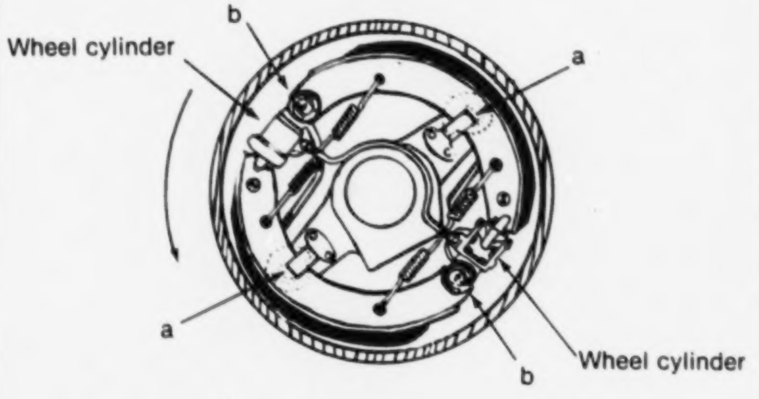

Eccentric cam A
Eccentric cam B
Forward shoe (long lining)
Reverse shoe (short lining)
Self-centering anchor

Used with permission of Raybestos/Brake Systems, Inc.

> **NOTE:** This brake anchoring design provides no servo action, but the primary shoe is self-energizing. It is also self-centering because the shoe anchor does not fix the location of the shoes in any specific relationship to the drum. The shoes can move up or down until centered. One rarely used mounting includes a combination anchor pin and eccentric/anchor adjuster in each shoe rather than one self-centering anchor.

- **Double-anchor double-cylinder**

FIGURE 20

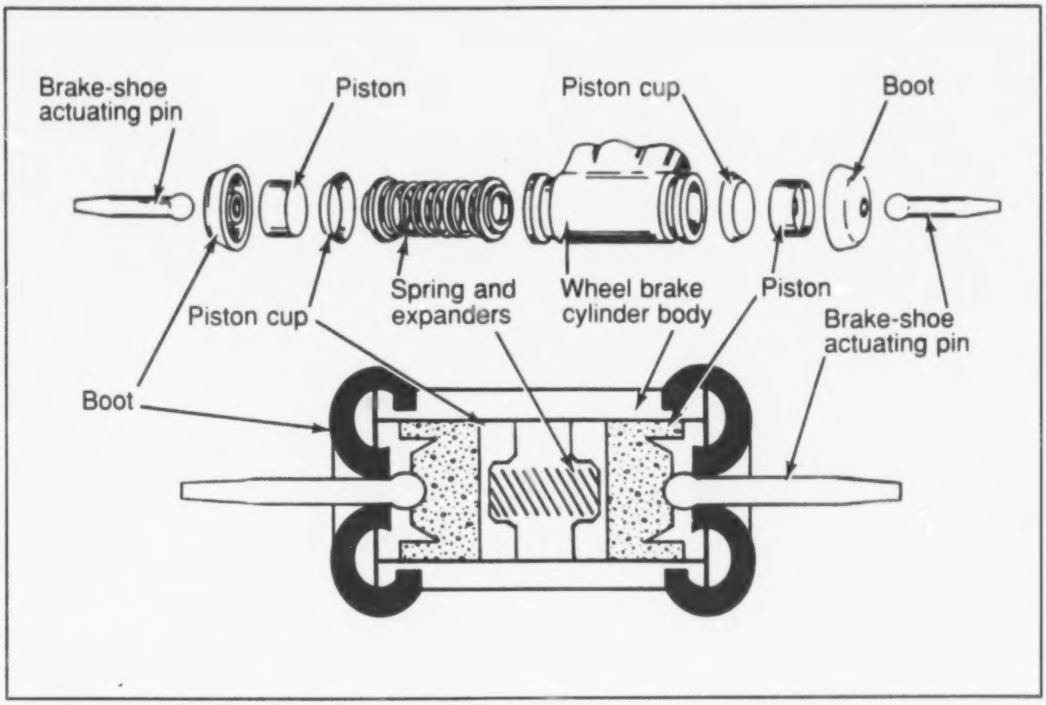


Used with permission of Raybestos/Brake Systems,Inc.

NOTE: In this design, the free end of each shoe is actuated toward the direction of rotation, and both shoes are self-energizing. Two single-piston cylinders are used. Brake adjustment is provided by eccentrics—(a) in illustration—and the anchors (b) are also eccentrics so that the shoes may be centered in relationship to the drum.

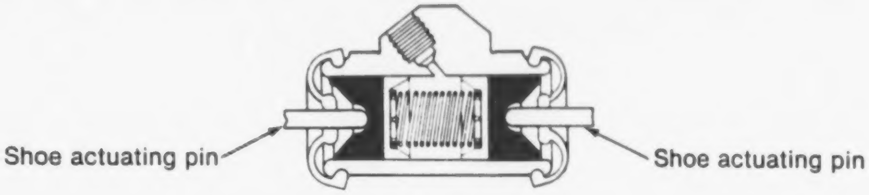
OBJECTIVE 9 **Recall basic components of a typical wheel cylinder by writing the names of components shown on an illustration.**

FIGURE 21


Brake-shoe actuating pin
Piston
Piston cup
Boot
Piston cup
Spring and expanders
Wheel brake cylinder body
Piston
Brake-shoe actuating pin
Boot

WHEEL CYLINDER OPERATION

Wheel cylinders operate on basic hydraulic principles. The space in the cylinder bore between the cups must remain filled with fluid at all times. When the brake pedal is depressed, additional brake fluid is forced into the cylinder bore. The additional fluid, which is under pressure, moves the cups and pistons outward in the bore as shown below. This piston movement forces the shoe actuating pins and brake shoes outward to contact the drum and thus apply the brakes. On some brakes, the end of the shoe web bears directly against the pistons, and shoe actuating pins are not used.

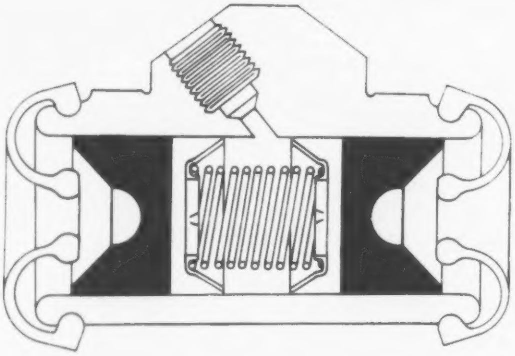


Adapted with permission of Allied Aftermarket.

OBJECTIVE 10 **Recall types of wheel cylinders used with drum brakes by writing the correct names for given illustrations.**

- **Double-piston straight-bore**

FIGURE 22

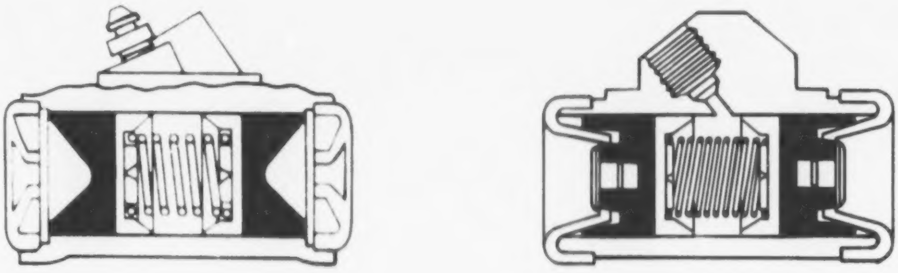


Used with permission of Allied Aftermarket.

NOTE: The ***double-piston straight-bore*** wheel cylinder is the type most commonly used on modern automobile brakes.

DESIGN VARIATIONS OF DOUBLE-PISTON STRAIGHT-BORE

Double-piston straight-bore wheel cylinder designs may vary in the method of attaching the dust boots to the cylinder body. Illustration (a) below shows boots fitted inside the end of the cylinder body. Illustration (b) shows external press-on boots.



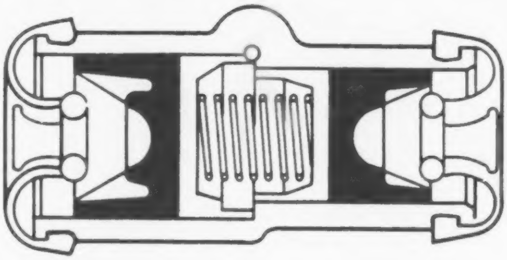
(a) Boots fit inside ends of cylinder body.

(b) Boots are pressed over outside of cylinder body.

Used with permission of Allied Aftermarket.

- **Double-piston step-bore**

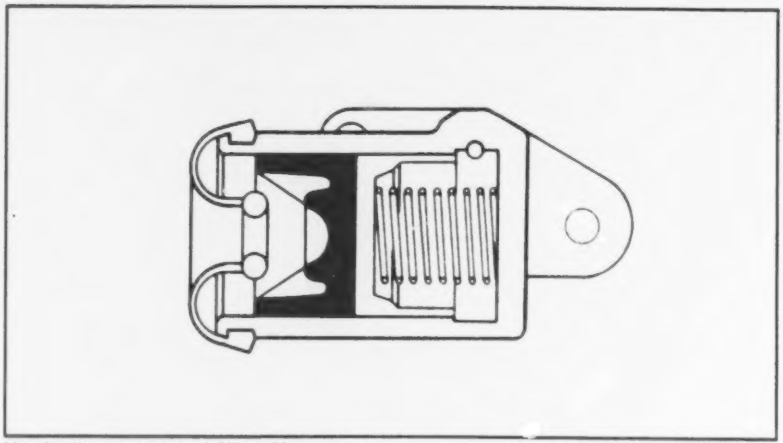
FIGURE 23



Used with permission of Allied Aftermarket.

- **Single-piston**

FIGURE 24



Used with permission of Allied Aftermarket.

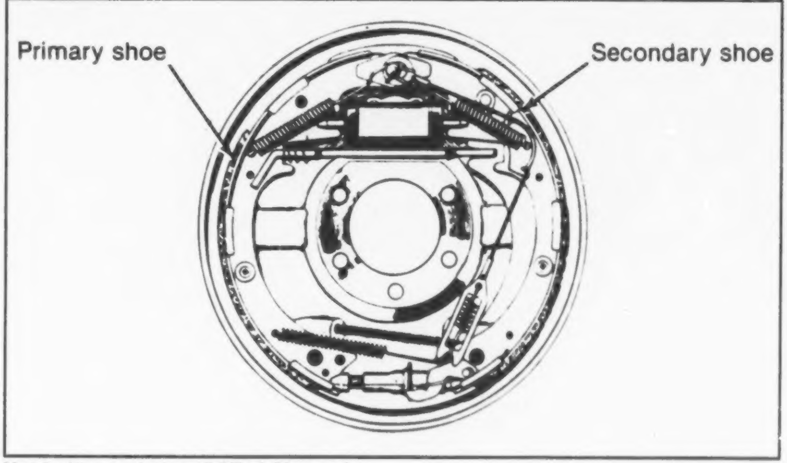
NOTE: ***Single-piston*** wheel cylinders may be fixed (generally used in pairs), floating (used mostly on imported vehicles), or sliding (used on some imports).

OBJECTIVE 11

Recognize types of automatic drum brake shoe adjusters by labeling illustrations with the correct names.

- **Cable**

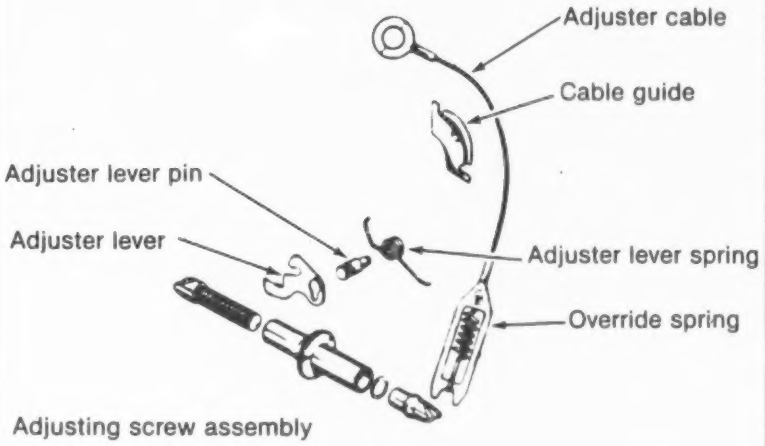
FIGURE 25


Primary shoe
Secondary shoe

Used with permission of Allied Aftermarket.

NOTE: As shoe travel outward increases with lining wear, a ***cable*** pulls the adjuster lever up enough to engage the next tooth on the star wheel when brakes are applied in reverse.

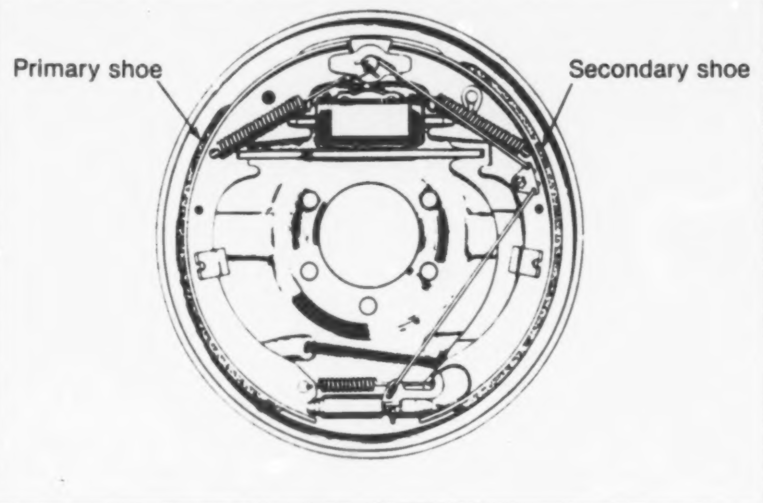
AUTOMATIC CABLE ADJUSTER PARTS


Adjuster cable
Cable guide
Adjuster lever pin
Adjuster lever
Adjuster lever spring
Override spring
Adjusting screw assembly

Used with permission of Allied Aftermarket.

- **Link (crank)**

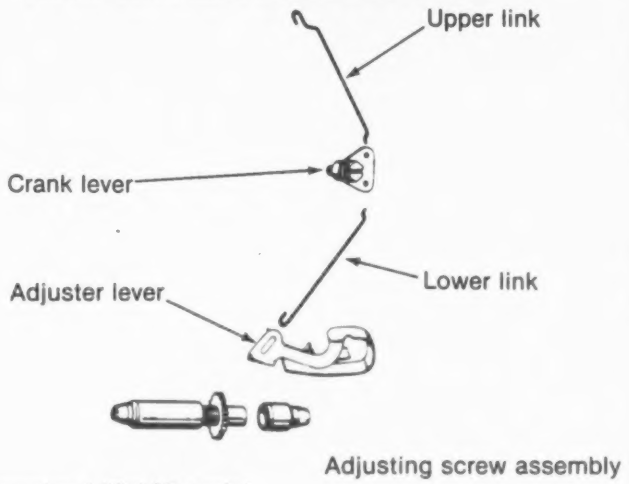
FIGURE 26


Primary shoe
Secondary shoe

Used with permission of Allied Aftermarket.

NOTE: The ***link-*** or ***crank-type*** adjuster operates in the same manner as the cable-type automatic adjuster; except the adjuster lever is actuated with a link or wire when brakes are applied in reverse.

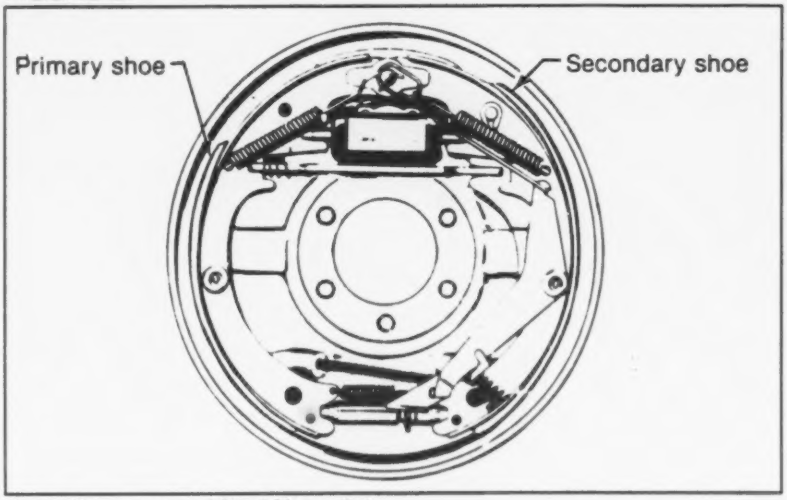
AUTOMATIC LINK ADJUSTER PARTS


Upper link
Crank lever
Lower link
Adjuster lever
Adjusting screw assembly

Used with permission of Allied Aftermarket.

- **Lever**

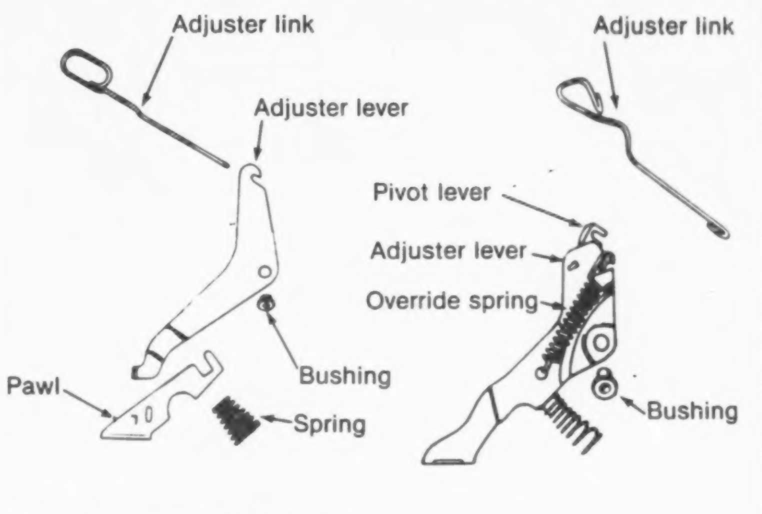
FIGURE 27


Primary shoe
Secondary shoe

Used with permission of Allied Aftermarket.

NOTE: In this design, a one- or two-piece ***lever*** is attached to the brake shoe and pivots as lining wears to engage a pawl in the star-wheel teeth. The two-piece lever is an earlier design.

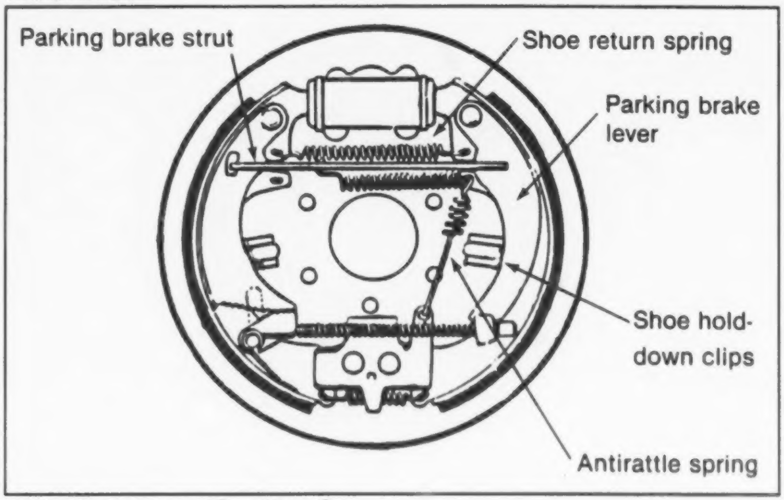
AUTOMATIC LEVER ADJUSTER PARTS


Adjuster link
Adjuster link
Adjuster lever
Pivot lever
Adjuster lever
Override spring
Bushing
Pawl
Spring
Bushing

Used with permission of Allied Aftermarket.

- **Ratchet**

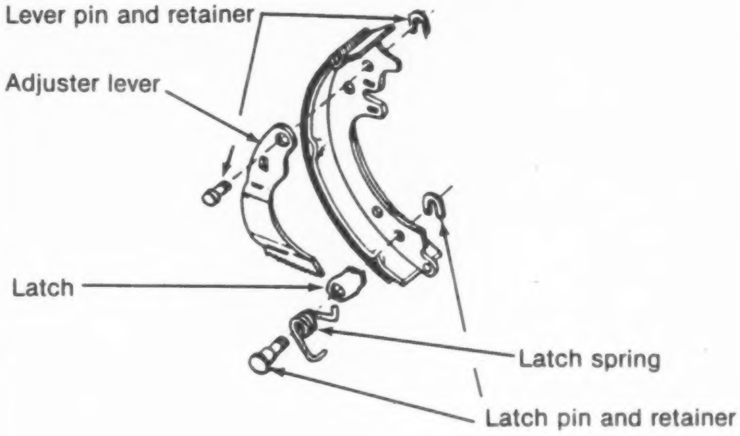
FIGURE 28


Parking brake strut
Shoe return spring
Parking brake lever
Shoe hold-down clips
Antirattle spring

Used with permission of Ford Motor Co.

NOTE: This adjuster has an automatic adjuster lever (large ***ratchet***) and a smaller lever (small ***ratchet***), both of which have interlocking teeth. As the lining wears, the large ratchet must pivot farther and catch the next tooth on the smaller ratchet, thus adjusting shoes to proper clearance.

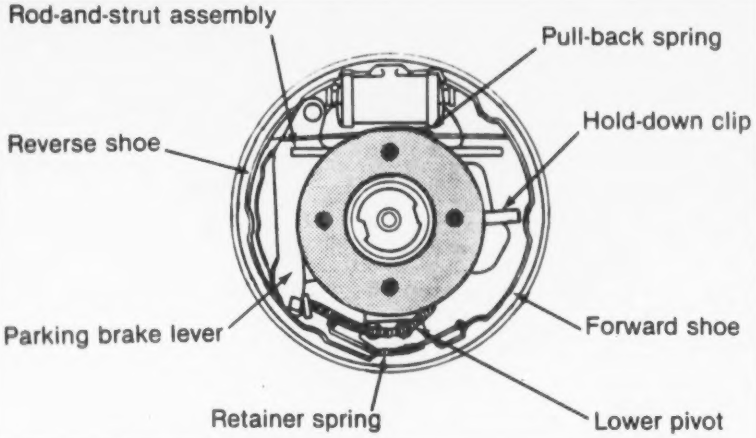
AUTOMATIC RATCHET ADJUSTER PARTS


Lever pin and retainer
Adjuster lever
Latch
Latch spring
Latch pin and retainer

Used with permission of Ford Motor Co.

- **Rod-and-strut assembly**

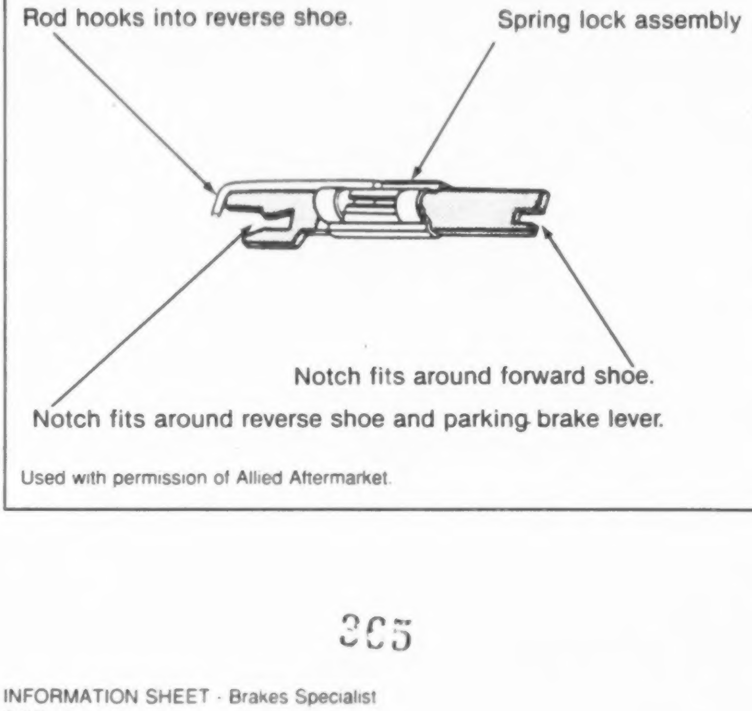
FIGURE 29


Rod-and-strut assembly
Pull-back spring
Reverse shoe
Hold-down clip
Parking brake lever
Forward shoe
Retainer spring
Lower pivot

Used with permission of Allied Aftermarket.

NOTE: Adjustment with this type of adjuster occurs only with parking brake operation. Upon use of the parking brake, the strut engages the forward shoe against the brake drum. As the shoes pull apart, the rod pulls the spring-lock assembly to lengthen the strut. It is recommended that new adjuster assemblies of this type be installed with shoe replacement. Adjusters are not interchangeable from side to side of the vehicle.

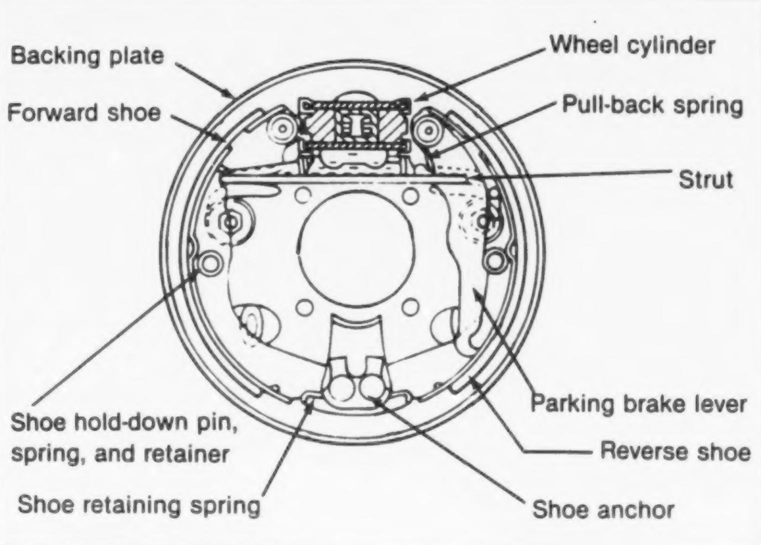
AUTOMATIC ROD-AND-STRUT ADJUSTER PARTS


Rod hooks into reverse shoe.
Spring lock assembly
Notch fits around forward shoe.
Notch fits around reverse shoe and parking brake lever.

Used with permission of Allied Aftermarket.

- **Eccentric cam**

FIGURE 30

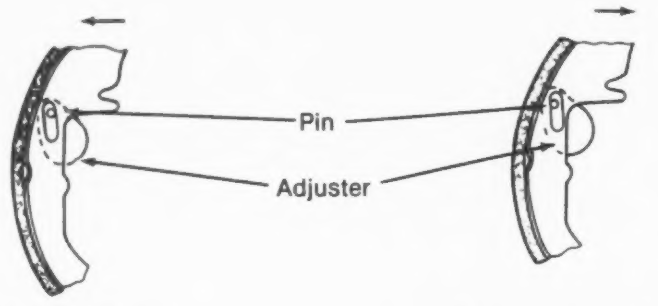

Backing plate
Wheel cylinder
Forward shoe
Pull-back spring
Strut
Parking brake lever
Shoe hold-down pin, spring, and retainer
Reverse shoe
Shoe retaining spring
Shoe anchor

Used with permission of Allied Aftermarket.

AUTOMATIC ECCENTRIC CAM ADJUSTER PARTS

Adjuster is rotated outward by shoe as brakes are applied.

Adjuster remains in new position as brakes are released. Shoe travel stops at contact with adjuster pin.


Pin
Adjuster

Brakes applied

Brakes released

Used with permission of Allied Aftermarket.

TROUBLESHOOTING CHART FOR DRUM BRAKES

NOTE: Conditions caused by brake systems and wheel bearings are described in the following chart; however, similar indications may result from steering and suspension problems.

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Low pedal (lack of reserve; pedal height increased by "pumping"; pedal goes to floor)	Low fluid level permits air to enter system	Refill and bleed master cylinder
	Leak in the hydraulic system	Check master cylinder, wheel cylinders, brake lines, and hoses for leakage; repair or replace faulty parts
	Improper adjusted master cylinder or power brake pushrod	Adjust pushrod free play
	Excessive clearance between drums and linings	Adjust the brakes
	Brakes out of adjustment	If automatically adjusted, make several forward and reverse stops, or set and reset the parking brake, whichever actuates the automatic adjuster; if pedal does not come up, repair the automatic adjuster. On star-wheel-type, check the pawl advancement. If manually adjusted, adjust as needed; repair and replace adjusters as needed
	Bent or distorted brake shoes	Replace shoes and linings in axle sets only

CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTION
Pedal pulsation (pedal chatter, fight, or vibration while braking)	Worn or damaged front wheel bearings	Replace bearings
	Out-of-round drums	Recondition or replace drums in axle sets
	Bent rear axle	Replace axle
	Loose backing plate	Tighten to specifications
	Bent backing plate	Replace backing plate
	Excessive drum runout due to faulty installation of new drums	Remove and properly install the drums
Spongy or springy pedal	Air in brake system	Refill and bleed; check for possible fluid leaks at • master cylinder secondary cup • wheel cylinders or disc calipers • hose and line connections • power brake vacuum line; disconnect vacuum line and check for presence of fluid
	Fluid boil, vaporized by overheating	Check by opening bleeder screw; bleed system and correct accordingly
	Loss of system residual pressure, permitting air to seep into wheel cylinders	Replace residual pressure check valve
	Improper use of parking brake (after pedal is released), causing a pressure loss	Set parking brake before releasing pedal

CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTION
Spongy or springy pedal (continued)	Shoes bent, distorted, or not centered in drum	Replace shoes and linings in axle sets; adjust anchor pins (if provided); check lining seating and drum eccentricity
	Brake drum too thin	Replace drums in axle sets
Hard pedal (excessive stopping distance and/or effort required to stop vehicle)	After extended use, linings worn out or poor quality brake linings	Replace with approved shoes and linings in axle sets only
	"Faded," overheated condition, glazed linings, "blued" or heat-checked drums	Lightly sand lining surface or replace shoes and linings in axle sets; recondition or replace drums
	Excessive lining clearance	Check and correct pawl or link advancement on automatic adjusters; adjust manual adjusters
	Grease-soaked or brake-fluid-soaked linings	Repair grease seal or wheel cylinder as necessary, and replace shoes and linings in axle sets only
	Low engine vacuum supply to power brake booster or defective power brake vacuum check valve	Tune or repair the engine to obtain correct vacuum, or replace check valve
	Faulty power brake booster	Replace power booster
	Loose or leaking vacuum hose to power brake booster	Tighten clamps or replace hose as required
	Wheel cylinder or master cylinder pistons stuck	Rebuild or replace appropriate cylinder
	Brake drum bell-mouthed or barrel-shaped	Refinish drum to proper limits, or replace (if beyond refinishing limits) in axle sets only

CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTION
Brakes drag, lock or overheat	Rough or corroded master cylinder bore; master cylinder bypass port blocked by dirt or swollen primary cup	Rebuild or replace master cylinder **NOTE:** Do **not** rebuild aluminum master cylinders.
	Binding brake pedal linkage; bind prevents the return of pedal against its stop	Free up and lubricate
	Weak pedal return spring	Replace spring
	Valve leaks, weak reaction springs, or bind in power mechanism	Repair or replace power section of power brake
	Loose or worn front wheel bearings	Adjust to specifications or replace
	Defective brake hose or lines preventing return of brake fluid	Replace faulty lines or hoses
	Soft or swollen rubber parts caused by contaminated or incorrect brake fluid	Replace all rubber parts (including hoses), flush hydraulic system, and fill with approved brake fluid
	Incorrect, bent, or distorted shoes	Replace shoes and linings in axle sets
	Weak or broken shoe return springs	Replace shoe return springs
	Incorrect linings, linings loose on shoes, or grease or brake fluid on linings	Replace with correct shoes and linings in axle sets only; repair grease seal or wheel cylinders
	Improper brake shoe adjustment	Adjust shoes and repair automatic adjuster if necessary
	Shoes not centered in drums	Adjust anchor pin if provided

CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTION
Brakes drag, lock or overheat (continued)	Loose or distorted brake backing plate	Tighten or replace backing plate
	Scored, hot-spotted, or out-of-round drums	Refinish drums or replace in axle sets
	Frozen parking brake cables	Free up and lubricate cables or replace
	Piston stuck in wheel cylinder	Rebuild or replace wheel cylinder
	Plugged master cylinder vent port(s), and/or swollen or damaged master cylinder primary cups	Rebuild or replace master cylinder; flush hydraulic system and fill with approved brake fluid **NOTE**: Do **not** rebuild aluminum master cylinders.
Severe stops, dive (brakes sensitive to light pedal effort, excessive wheel skid)	Unbalanced "pull," any condition causing brake to grab	Refer to next section "Car pulls to one side"
	Abnormal front-end dive	
	• Front suspension wear or misalignment causing abnormal deflection, worn shocks, etc.	Align front end; repair or replace affected parts
	• Temporary morning sickness due to moisture or rust accumulation on cooled friction surfaces	No cause for worry if the conditions are temporary; if condition persists, repair affected parts
Car pulls to one side	Faulty suspension parts	Repair suspension system
	Incorrect linings on shoes	Replace with correct shoes and linings

CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTION
Car pulls to one side (continued)	Brake fluid, oil, grease, mud, water, or dirt on linings	Repair grease seal or wheel cylinder as necessary; clean affected parts, replace shoes and linings in axle sets only
	Distorted or incorrect shoes	Replace with correct shoes and linings
	Shoes not centered in drums	Replace with correct shoes and linings
	Loose or distorted brake backing plate	Tighten or replace plate
	Weak shoe return springs or hold-downs	Replace with new parts
	Drum bell-mouthed, barrel-shaped, threaded, cracked, or containing high hard spots	Recondition or replace drums in axle sets
	Sticking wheel cylinder piston	Repair or replace wheel cylinder
	Abnormal deflection, wear and improper alignment including caster and camber, weak or broken springs, broken spring center bolt, loose U-bolts, loose steering gear or tie rods, worn shock absorbers, etc.	Check and correct front-end alignment; repair or replace faulty parts
	Faulty brake hose or obstruction in brake line	Replace hose or line
	Charred or badly worn brake linings	Replace linings (in axle sets) and other worn parts
Noises		
• Squeal	Improper arc grind or eccentric drum causes new lining to "pinch" against drum	Reface or grind drums, or regrind or replace linings in axle sets only

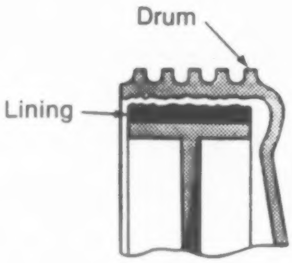
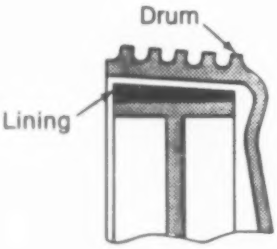
CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTION
Noises (continued)		
• Squeal (continued)	Dust or other particles embedded in lining	Remove foreign matter; replace lining if necessary in axle sets only
	Loose lining rivets	Reset rivets or reline the shoes if rivet holes in lining are "wallowed"
	Loose backing plate, anchor, drum, or wheel cylinder	Tighten all loose parts or replace as necessary
	Shoes scrape on support pads	Clean and lubricate
	Weak or broken shoe hold-down springs	Replace springs
	Backing plate bent, shoes twisted	Replace plate and/or shoes
	Drums out-of-round or out-of-square	Recondition or replace drums in axle sets only
	Drum silencer (screen door) spring missing or weak	Replace spring
• Grind	Lining worn; rivets or shoe table rub on drum	Replace shoes and linings in axle sets; recondition or replace drums if damaged
	Foreign material embedded in lining	Replace shoes and linings in axle sets
	Rough drum surface	Recondition or replace drums in axle sets
• Chatter	Lining clearance too tight or too loose	Adjust linings to proper clearance
	Loose backing plate	Tighten or replace plate

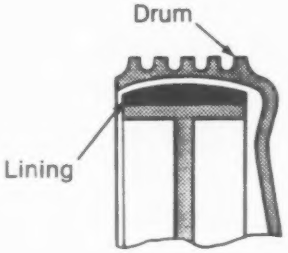
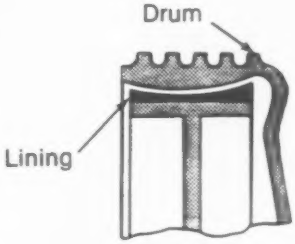
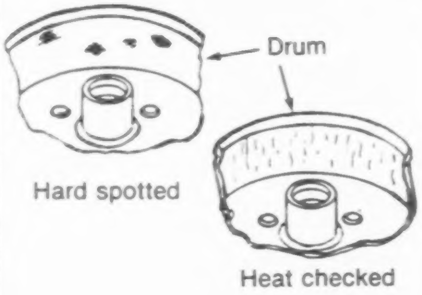
CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTION
Noises (continued)		
• Chatter (continued)	Grease, fluid, or dust on lining surface	Recondition or replace linings in axle sets
	Twisted brake shoe	Replace shoes
	Drum out-of-round, bell-mouthed, barrel-shaped, or cracked	Recondition or replace drum
	Weak or broken return spring	Replace springs
	Loose spindle and/or suspension parts	Adjust or replace as needed
	Improper lining grind	Replace linings in axle sets
• Click (shoes lift off support pads and snap back)	Threaded drum surface	Replace or recondition drum
	Weak hold-downs	Replace hold-downs
	Grooves in brake shoe support pads	Stone smooth and lubricate
• Thumps/clunks	Excessive lining clearance (applying, linings thump drums; releasing, shoes clunk on anchors)	Adjust brakes to proper clearance

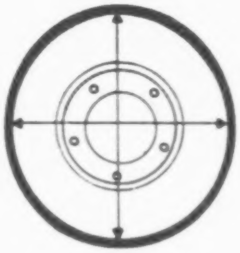
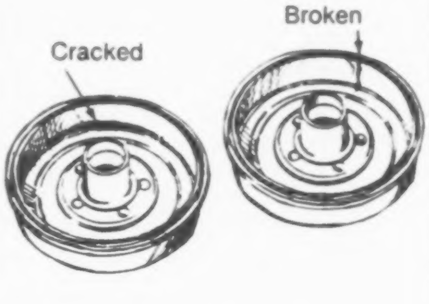
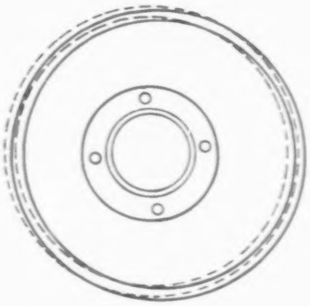
This Supplement is adapted from *Hydraulic Disc and Drum Brake Diagnostic and Reconditioning Manual, AU-1600/Feb., 1984*, by the Wagner Division, Cooper Industries, Inc.

CAUSES OF DRUM BRAKE DEFECTS

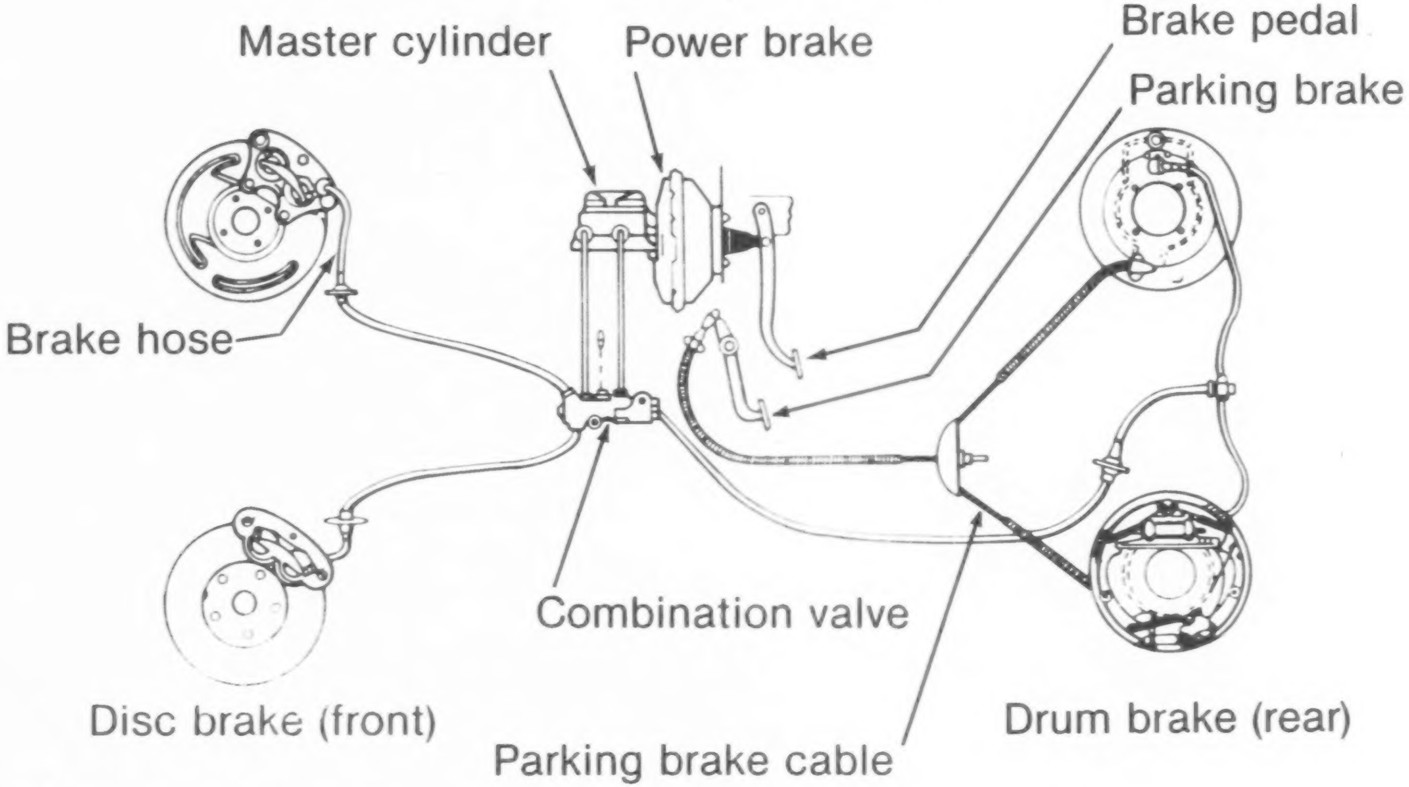
NOTE: Brake drums provide the surface against which the linings are pressed to provide braking friction. Most drums are made of heavy cast iron or steel. They must be able to withstand high pressures without excessive flexing and must also dissipate large quantities of heat generated during brake application.

DEFECT	POSSIBLE CAUSE	EXAMPLE
Scored	Brake dust and dirt between brake lining and drum Glazed brake lining hardened by high heat Excessive lining wear exposing rivet head or shoe steel	 Used with permission of Allied Aftermarket.
Bell-mouthed	Extreme heat and braking pressures Oversized drums	 Used with permission of Allied Aftermarket.

DEFECT	POSSIBLE CAUSE	EXAMPLE
Barrel-shaped (concave)	Extreme braking pressure distorts shoe platform so that braking pressure wears pattern in center area of drum	 Used with permission of Allied Aftermarket.
Taper (convex)	Excessive heat or oversized drum causes greater wear pattern at closed end of drum and distorts open end of drum	 Used with permission of Allied Aftermarket.
Hard spotted/heat checked	Extreme operating temperatures create heat checks which are visible, or hard spots, which are not visible until drum is machined	 Used with permission of Allied Aftermarket.

DEFECT	POSSIBLE CAUSE	EXAMPLE
Out-of-round	Oversized drum Higher than normal operating temperatures Uneven shoe application Dragging parking brake	 Used with permission of Allied Aftermarket.
Cracked or broken	Wear and tear High operating temperature followed by rapid cooling Collision impact	 Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*
Eccentric (off center)	Application of parking brake when drums are overheated Improper lug nut torque Tightening lug nuts in improper sequence	

Components of a Tandem or Dual Brake System


Master cylinder

Power brake

Brake pedal

Parking brake

Brake hose

Combination valve

Disc brake (front)

Parking brake cable

Drum brake (rear)

TRANSPARENCY MASTER 1 Brakes Specialist
CIMC - II - 75

Used with permission of Allied Aftermarket

Parts of a Typical Drum Brake Shoe

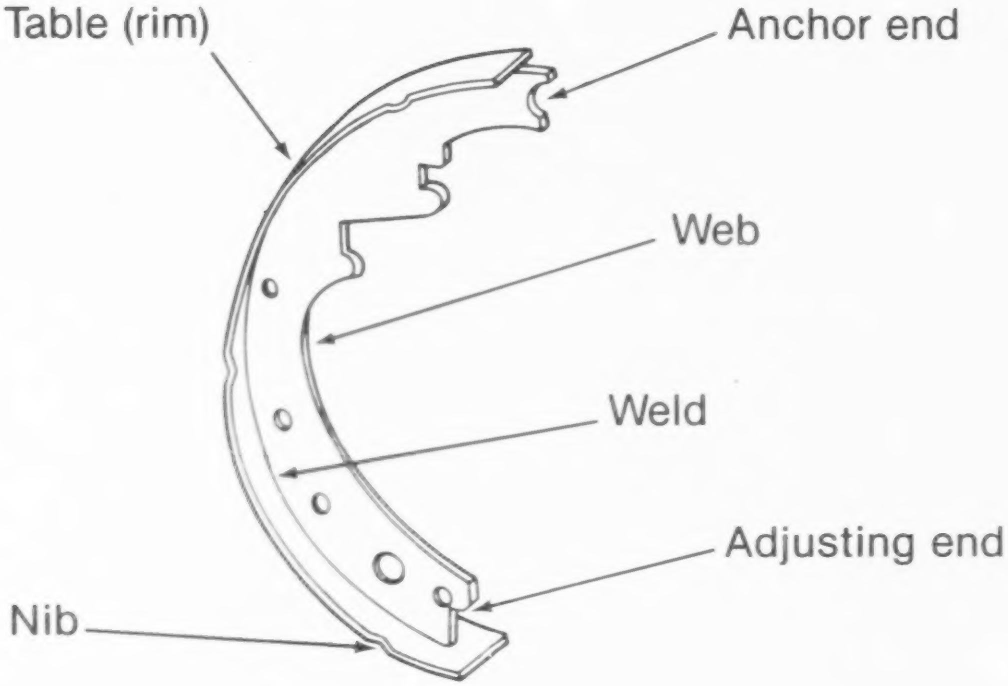
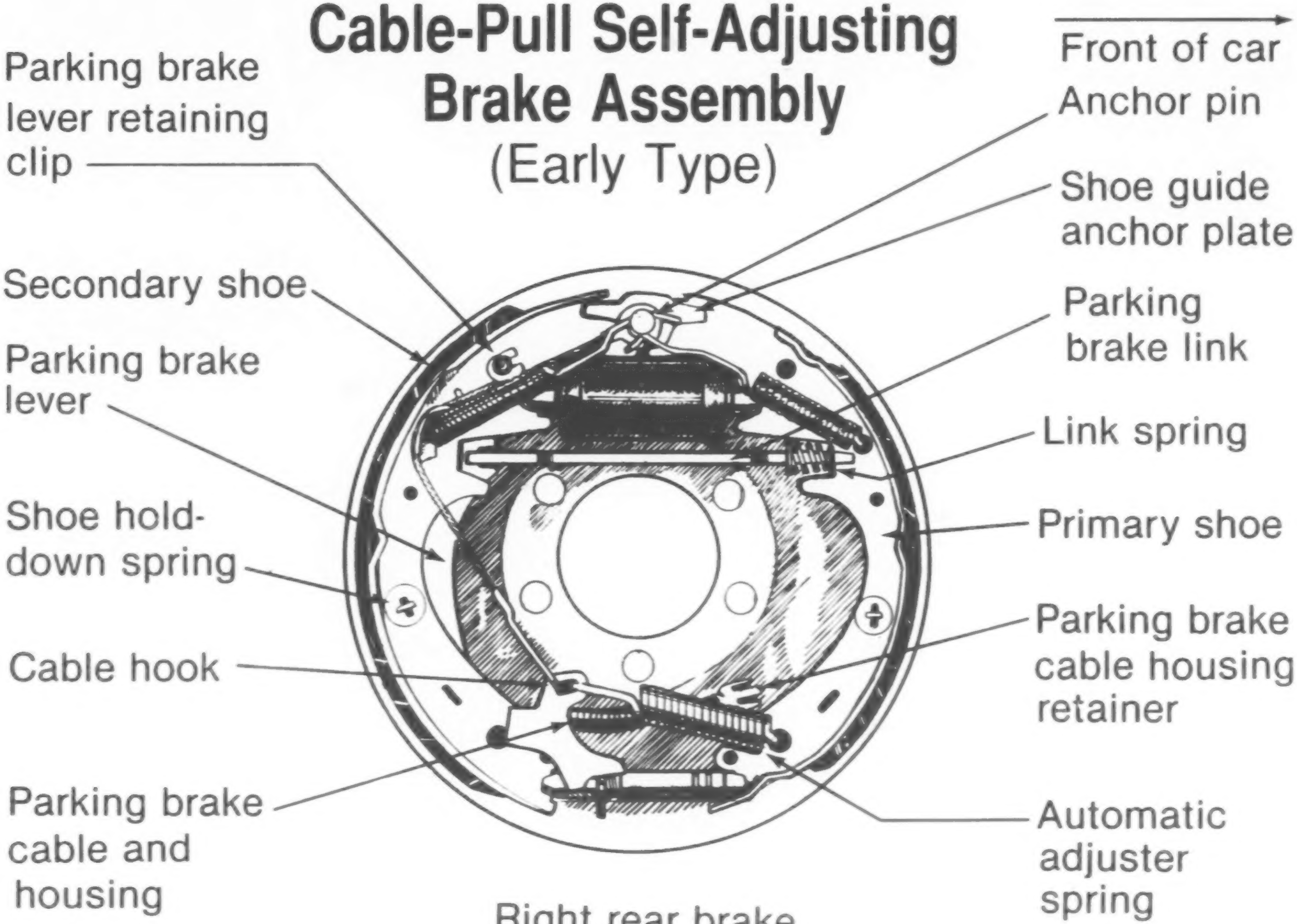


Table (rim)
Anchor end
Web
Weld
Adjusting end
Nib

Used with permission of Allied Aftermarket

Cable-Pull Self-Adjusting Brake Assembly

(Early Type)

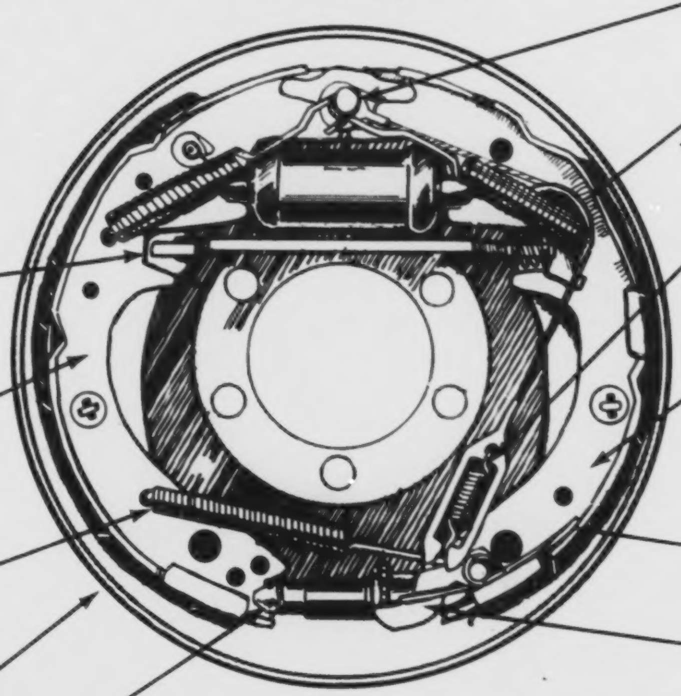

Front of car
Parking brake lever retaining clip
Anchor pin
Shoe guide anchor plate
Secondary shoe
Parking brake link
Parking brake lever
Link spring
Shoe hold-down spring
Primary shoe
Cable hook
Parking brake cable housing retainer
Parking brake cable and housing
Automatic adjuster spring

Right rear brake

Cable-Pull Self-Adjusting Brake Assembly

(Late Type)

← Front of car



Anchor pin

Cable guide

Adjuster overload spring

Secondary shoe

Lever spring

Adjusting lever

Star-wheel adjuster assembly

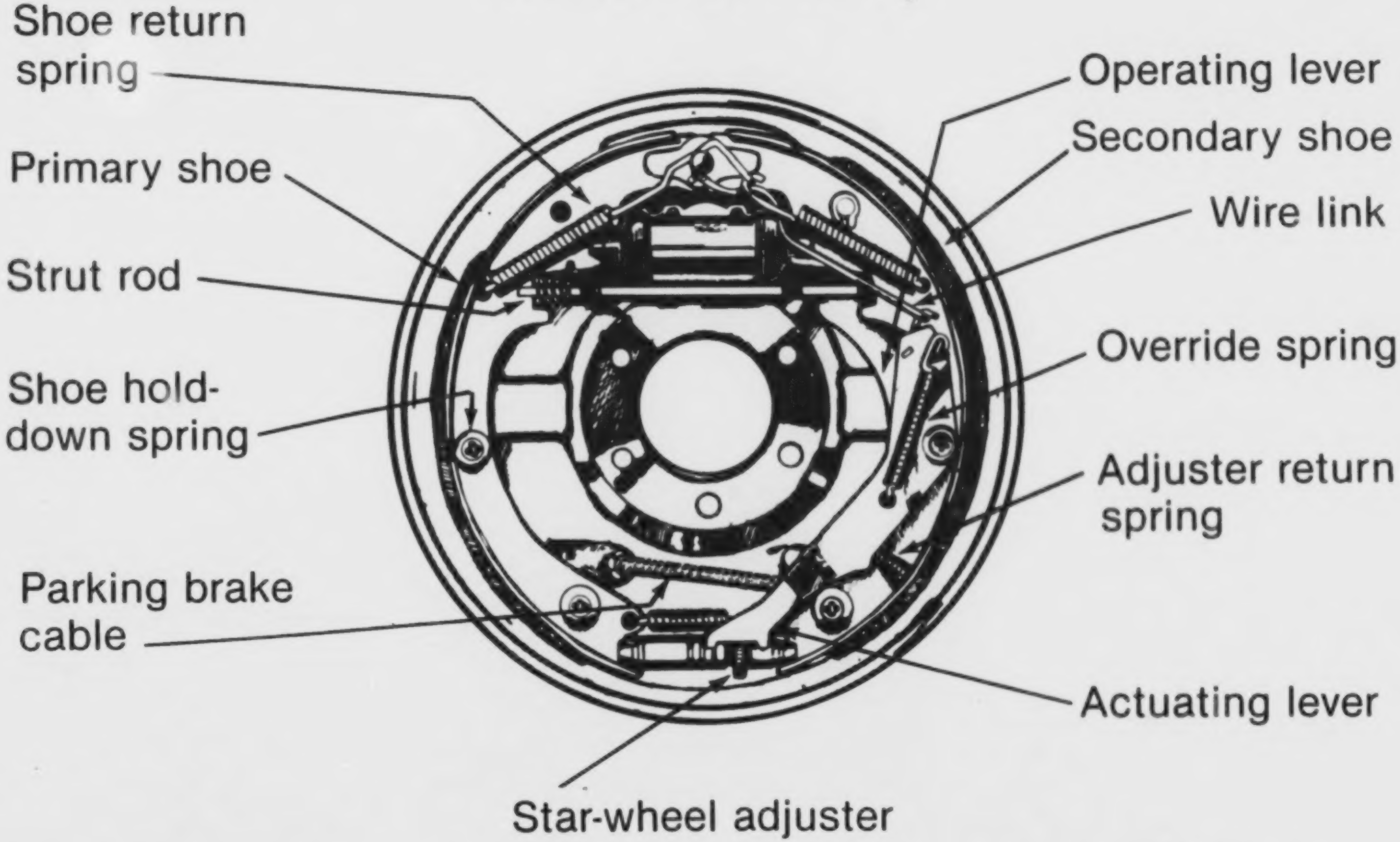
Support plate

Automatic adjuster spring

Primary shoe

Strut

Lever-Type Self-Adjusting Brake Assembly


Shoe return spring
Primary shoe
Strut rod
Shoe hold-down spring
Parking brake cable
Operating lever
Secondary shoe
Wire link
Override spring
Adjuster return spring
Actuating lever
Star-wheel adjuster

ACTIVITY SHEET 1

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  — Using standard references

  — Following written instructions

  EMPLOYABILITY SKILLS

  — Mastering a specific job task/procedure

- If students have difficulty using standard references:

  — Locate and explain the purpose of the reference section of the library.

  — Discuss the fact that each standard reference provides a specific type of information.

  — Review each element of the service manual that might be used, including exploded illustrations, rotated illustrations, parts lists, allowable variance charts, and procedure instructions. Discuss the use for and importance of each element.

  — Review the use of other references, including computer data bases and telephone help lines.

- If students have difficulty following written instructions:

  — Discuss the possible consequences of not following instructions precisely.

- Have them read the instructions several times, noting the key words and ideas.
- Discuss the difference between text guidelines and service manual instructions.

- If students have difficulty mastering a specific job task/procedure:
  - Emphasize the fact that practice makes a person proficient and proficiency makes a person confident.
  - Suggest they study each component of the procedure to determine which area is causing difficulty.
  - Review the entire procedure.
  - Team them with proficient students or professionals to practice the procedure.

ACTIVITY SHEET 2

Development of:
READING SKILLS

- Introduce the assignment to the students by discussing why reading skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  - Interpreting graphics & symbols

- If students have difficulty interpreting graphics and symbols:
  - Review the graphics, identifying landmarks and actions taking place.
  - Compare various types of graphics included in the text, including photographs, line drawings, exploded views, and broken views.

ACTIVITY SHEET 1

SERVICING DRUM BRAKES

II

Name ______________________________ Score __________

DETERMINING CORRECT SPECIALTY TOOLS FOR SERVICING DRUM BRAKES

INTRODUCTION

To effectively and correctly service drum brakes, the Brakes Specialist must be able to identify the correct tools for the service situation and be able to use the tools correctly. There are a number of specialty tools that are designed for use when performing drum brake service, and these are listed and illustrated in Objective 2. The following problems will help you become familiar with the appropriate uses of these tools.

DIRECTIONS

Read each of the following situations. Then in the blanks below each, write the name of the correct tool that the Brakes Specialist should use in that situation.

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

Job Acquisition/Development Skills
- Master specific job task/procedure

1. A technician is servicing a wheel cylinder. She has removed the wheel cylinder and placed it in a vise and is now ready to recondition the cylinder bore. What tool would she use?

   ____

2. A technician has finished service on a wheel cylinder and has reinstalled it and other related hardware. He now wants to open the wheel cylinder screws to bleed the system. What tool would he use?

   ____

3. A technician is removing, cleaning, and inspecting brake shoes, linings, and related hardware. He will not be rebuilding or replacing the wheel cylinder as part of the brake shoe replacement procedure. What tool must he use to prevent hydraulic pressure from pushing the wheel cylinder pistons and cups too far out in the bore when he removes the brake shoe retracting springs?

   ____

4. A technician is preparing to remove, clean, and visually inspect brake drums. What equipment must she install to clean brake lining dust from the drum assembly and to protect herself from asbestos contamination?

____

5. A technician is removing adjuster hardware from the drum brake backing plate. She is ready to remove the hold-down springs. What tools should she use?

____

6. A technician is ready to reassemble the shoes, linings, and related hardware on a drum brake backing plate. He must stretch the retracting springs over the anchor pin for reinstallation. Which tool should he use?

____

7. A technician has removed the drums from a vehicle. On inspection he finds that the drums are slightly scored. What tool must he use to correct this problem?

____

8. A technician finds that he needs to back off the star wheel for adjustment of lining-to-drum clearance. What tool would he use?

____

9. A technician needs to remove and reinstall the retracting and adjusting springs on a drum brake assembly. What tool would she use?

____

10. A technician has removed the drums from a vehicle and now needs to measure them to determine whether they are out-of-round. What tool would he use?

____

11. A technician has removed, cleaned, and inspected brake shoes and related hardware. Now he has reassembled the assembly and needs to set lining to drum clearance. What tool would he use?

____

ACTIVITY SHEET 2

SERVICING DRUM BRAKES

II

Name ______________________________ Score __________

ANSWER GENERAL QUESTIONS ABOUT DRUM BRAKES

INTRODUCTION

To become certified as a Brakes Specialist, you must pass a test on the brake system compiled by the National Institute for Automotive Service Excellence. The certification test covers all aspects of a vehicle's braking system. This activity sheet covers only drum brakes, but contains realistic questions similar in content and style to those found on the actual ASE certification test.

DIRECTIONS

Functional Reading Skills
- Interpret graphics and symbols

Read each of the following study questions twice. The second time you may notice a key word that you overlooked the first time. Every word in the question is important and may provide a clue to the right answer. Select the answer that is *most* correct and write its letter in the answer blank.

_____ 1. A honed wheel cylinder should be checked with an inside micrometer and should not exceed _____ over the original diameter.

a. 0.002″
b. 0.005″
c. 0.030″
d. 0.003″

_____ 2. The rubber strap wrapped around the brake drum during turning on the lathe is used to

a. Cool the drum
b. Shield operator from flying chips
c. Prevent drum expansion
d. Reduce vibration

_____ 3. On a drum brake system, the master cylinder maintains residual pressure in order to

a. Keep wheel cylinder cups sealed against cylinder
b. Prevent air from entering system
c. Both a and b
d. Neither a nor b

_____ 4. Two technicians are discussing the lining used in duo-servo brakes. Technician A says that the secondary lining is usually longer than the primary lining. Technician B says that the primary lining is usually narrower than the secondary lining. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 5. Which of the parts below keeps the brake shoes from turning with the drum when the brakes are applied?

a. Wheel cylinder
b. Hold-down assembly
c. Anchor pin or block
d. Star wheel adjuster

_____ 6. Which of the following should a technician use to clean the wheel cylinder after honing?

a. Hot water and soap
b. Denatured alcohol
c. Cleaning solvent
d. Kerosene

_____ 7. Two technicians are discussing the hazards of breathing asbestos dust. Technician A says that breathing asbestos dust may cause asbestosis. Technician B says that breathing asbestos dust may cause cancer. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 8. Modern brake shoes are usually ground at the factory so that they are slightly thinner at

a. The middle
b. The heel
c. The toe
d. Both b and c

_____ 9. The type of wheel cylinder most commonly used on modern automobile brakes is the

a. Double-piston straight-bore
b. Double-piston step-bore
c. Floating single-piston
d. Fixed single-piston

_____10. Common drum sizes used by American automobile manufacturers include all of the following except

a. 9"
b. 9½"
c. 10"
d. 10⅝"

_____11. In automatic adjustment systems if the actuating cable or link is attached to the brake shoe, adjustment takes place

a. Only when braking in a forward direction
b. Only when braking in reverse
c. When braking in either direction
d. Only when using the parking brake

_____12. Depending on the type of use to which a vehicle is subjected and the skills of the driver, brake lining life will average

a. 10,000 to 50,000 miles
b. 20,000 to 40,000 miles
c. 20,000 to 75,000 miles
d. 40,000 to 75,000 miles

_____13. Brake drum defects which may be corrected by refinishing with a lathe (if brake drum diameter after refinishing does not exceed manufacturer's specified maximum diameter) include all of the following except

a. Cracked
b. Eccentric (off center)
c. Scoring
d. Barrel shape

_____14. The type of adjuster that functions only with parking brake operation is

a. Cable
b. Rod-and-strut assembly
c. Link (crank)
d. Ratchet

_____15. After an automobile with drum brakes sits overnight, the pedal is low for the first stop in the morning. The rest of the day, the brakes are okay. Technician A says that this could be caused by low brake fluid level. Technician B says that this could be caused by a leaking residual valve. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

ACTIVITY SHEET ANSWERS

SERVICING DRUM BRAKES

II

ACTIVITY SHEET 1

1. Brake cylinder hone
2. Bleeder screw wrench
3. Wheel cylinder clamp
4. Enclosure-type brake cleaner
5. Hold-down spring tool
6. Retracting spring (brake spring) tool
7. Drum brake lathe
8. Drum brake adjusting spoon
9. Brake spring pliers
10. Brake drum micrometer
11. Drum-to-shoe gauge

ACTIVITY SHEET 2

1. a
2. d
3. c
4. c
5. c
6. b
7. c
8. d
9. a
10. d
11. c
12. b
13. a
14. b
15. b

ASSIGNMENT SHEET

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  — Using in-book references

  — Following written instructions

  EMPLOYABILITY SKILLS

  — Mastering a specific job task/procedure

- If students have difficulty using in-book reference tools:

  — Show students various in-book reference tools, including tables of contents, charts, illustrations, supplements, and unit objective statements. Identify the content of each and have students identify how each can be used for easy access to text information.

  — Encourage students to use bookmarks or other devices to mark most-used in-book references.

  — Explain to students that books are "random access" tools, meaning the information in them is accessible in any order. Compare books to items which are not random access such as cassette tapes or video films.

  — Have students create their own in-book references by keeping word lists, glossaries, time lines, or lecture notes and relating each piece of information to its textbook location.

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1.

ASSIGNMENT SHEET

SERVICING DRUM BRAKES

II

Name ______________________ Score ________

OBJECTIVE 12

Diagnose drum brake problems.

INTRODUCTION

Brake service is one of the most important and most common services performed in the automotive industry. State vehicle inspections are now required in most states, and an important part of that inspection is brake inspection. Therefore, vehicle owners need to have their vehicles' brakes periodically checked and repaired so their vehicles comply with state inspection standards. The normal wear and tear of everyday driving takes its toll on the vehicle's braking system. This means that the Brakes Specialist must be able to analyze customer complaints, inspect vehicle brake systems to locate problems, and ultimately diagnose the problems and repair them properly the first time.

DIRECTIONS

Research and Reference Skills
- Use in-book reference tools

Functional Reading Skills
- Follow written instructions

Job Acquisition/ Development Skills
- Master specific job task/ procedure

The following are multiple choice questions, each with three possible answers. Read each question carefully and then select the answer that is *most* correct. Refer to Supplements 1 and 2 and write the correct letters in the blanks.

_____ 1. A customer brings in a late-model automobile and complains that the pedal goes to the floor. Which of the following is a possible cause?

a. Excessive drum expansion
b. Bent or distorted brake shoes
c. Weak or broken shoe return springs

_____ 2. When servicing a customer's vehicle, you find that the brake shoe support pads are grooved. Which of the following was the customer's complaint?

a. Squealing noise on brake application
b. Grinding noise on brake application
c. Clicking noise upon brake application

_____ 3. You road test a vehicle to verify the customer's complaint that it pulls to the right. Upon inspection, you determine that this condition is caused by a sticking right wheel cylinder piston. Which of the following would be the proper corrective measure?

a. Repair or replace wheel cylinder
b. Lubricate piston with approved lubricant
c. Repair or replace piston

_____ 4. Following up on a customer's complaint, you find that one of the brake hoses is obstructed. Which of the following was the customer's complaint?

a. Spongy or springy pedal
b. Pedal pulsation
c. Car pulls to one side

_____ 5. A customer complains that she hears a thumping noise when she applies the brakes and a clunking noise when she releases the brakes. Which of the following do you explain to her as a possible cause?

a. Shoes are lifting off the support pads and snapping back due to a threaded drum surface
b. Lining is worn causing the rivets to rub on the drum
c. Excessive lining clearance causes the linings to contact drums and shoes to contact anchors

_____ 6. The customer complains of pedal pulsation. Which of the following is a possible cause?

a. Brake drum bell-mouthed or barrel shaped
b. Brake drum too thin
c. Excessive drum runout

_____ 7. When servicing a customer's vehicle, you find that the brake backing plate is bent. Which of the following would be the proper corrective measure?

a. Machine backing plate to recommended dimension
b. Replace backing plate
c. Adjust anchor pin (if provided)

_____ 8. When servicing a vehicle, you find that the linings are soaked with brake fluid. You repair the wheel cylinder and replace both shoes and linings in axle sets. Which of the following was the customer's complaint?

a. Excessive pedal pressure is required to stop the vehicle
b. Abnormal front-end dive
c. Pedal goes to the floor

_____ 9. When servicing a vehicle, you find that the brake shoes are improperly adjusted, causing the brakes to drag. Which of the following would be the proper corrective measure?

a. Replace shoe return springs
b. Adjust shoes and repair automatic adjuster if necessary
c. Adjust anchor pin (if provided)

_____10. The customer complains of a squealing noise upon brake application. Which of the following is a possible cause?

a. Drum silencer spring missing or weak
b. Loose spindle and/or suspension parts
c. Excessive lining clearance

_____11. When inspecting a vehicle, you find that the drum brake lining is scored. Which of the following is a possible cause?

a. Oversized drums
b. Brake dust and dirt between brake lining and drum
c. Dragging parking brake

_____12. While performing a brake inspection, you find that the brake drums are cracked and broken. Which of the following is a possible cause?

a. High operating temperature followed by rapid cooling
b. Excessive lining wear exposing rivet head or shoe steel
c. Uneven shoe application

_____13. Which of the following brake drum defects is caused by tightening lug nuts in the improper sequence?

a. Eccentric (off center)
b. Out-of-round
c. Barrel-shaped (concave)

_____14. When inspecting the brakes on a customer's vehicle, you find the brakes drums are out-of-round. Which of the following is a possible cause?

a. Collision impact
b. Improper lug nut torque
c. Uneven shoe application

_____15. After machining a brake drum you notice hard spots are present on the drum. Which of the following is a possible cause of this defect?

a. Excessive lining wear exposing rivet head or shoe steel
b. Extreme operating temperatures
c. Uneven shoe application

SERVICING DRUM BRAKES

1. b
2. c
3. a
4. c
5. c
6. c
7. b
8. a
9. b
10. a
11. b
12. a
13. a
14. c
15. b

JOB SHEET 1

Development of:
READING SKILLS
WRITING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, writing, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  — Using standard references

  — Following written instructions

  — Interpreting graphics & symbols

  WRITING SKILLS

  — Completing forms and records

  EMPLOYABILITY SKILLS

  — Mastering a specific job task/procedure

  — Practicing good work habits/attitudes

- If students have difficulty completing forms and records:

  — Examine the structure of the forms being used.

  — Stress the importance of accurate, legible records.

  — Review the use of the forms.

- If students have difficulty practicing good work habits/attitudes:

  — Encourage them to become familiar with the entire procedure before they begin the work.

- Discuss the role that good work habits and attitudes have in obtaining and retaining employment.
- Discuss what behaviors and attitudes constitute good work habits.
- Make sure the student knows what is expected of him or her.

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheets 1 & 2.

JOB SHEET 2

Development of:
READING SKILLS
MATHEMATICS SKILLS
SCIENCE SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, mathematics, science, and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

READING SKILLS

- Using standard references
- Following written instructions
- Interpreting graphics & symbols

MATHEMATICS SKILLS

- Using English & metric measures
- Making measurements

SCIENCE SKILLS

- Using scientific instruments (micrometer)

EMPLOYABILITY SKILLS

- Mastering a specific job task/procedure
- Practicing good work habits/attitudes

- If students have difficulty using English and metric measures:
  - Suggest that they look at a yardstick or tape that is marked in both English and metric and study the measurements until there is a concrete idea about the lengths of different units of measurement.
- If students have difficulty using English and metric measures or making measurements:
  - Review the units of measure in the English and metric systems.
  - Determine which system is needed for this procedure.
  - Demonstrate the correct way to measure using the specific measuring instrument.
  - Have students convert measurements to become accustomed to their relative sizes.
  - As work progresses, have students make measurements in one, estimate the measurement in units of the other system, then convert the measurement or remeasure using the other system.
- If students have difficulty using scientific instruments (micrometer), review the correct procedure for use.
- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheets 1 & 2 and Job Sheet 1.

JOB SHEETS 3 & 5

Development of:
READING SKILLS
MATHEMATICS SKILLS
SCIENCE SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, mathematics, science, and employability skills are important.

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- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  — Using standard references

  — Following written instructions

  — Interpreting graphics & symbols

  MATHEMATICS SKILLS

  — Using English & metric measures

  — Making measurements

  SCIENCE SKILLS

  — Using scientific instruments (micrometer, rule, gauges)

  EMPLOYABILITY SKILLS

  — Mastering a specific job task/procedure

  — Practicing good work habits/attitudes

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheets 1 & 2 and Job Sheet 2.

JOB SHEET 4

Development of:
READING SKILLS
MATHEMATICS SKILLS
SCIENCE SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, mathematics, science, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

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READING SKILLS

- Using standard references
- Following written instructions
- Interpreting graphics & symbols

MATHEMATICS SKILLS

- Using English & metric measures
- Interpreting charts & tables
- Making measurements

SCIENCE SKILLS

- Using scientific instruments (rule, feeler gauge)

EMPLOYABILITY SKILLS

- Mastering a specific job task/procedure
- Practicing good work habits/attitudes

- If students have difficulty interpreting charts and tables:
  - Present a variety of tables used every day. These might include maps and mileage charts, order forms, parts lists, and nutrition charts.
  - Have students identify what is listed in each row and column.
  - Indicate use aids frequently added to charts and encourage students to customize their own charts. Aids might include color highlighting most-used columns, adding spaces or lines every column or every five rows, and laminating frequently-used charts.
- If students have difficulty practicing good work habits/attitudes:
  - Encourage them to become familiar with the entire procedure before they begin the work.

- Discuss the role that good work habits and attitudes have in obtaining and retaining employment.
- Discuss what behaviors and attitudes constitute good work habits.
- Make sure the student knows what is expected of him or her.

JOB SHEET 6

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING SKILLS

  - Using standard references
  - Interpreting graphics & symbols

  EMPLOYABILITY SKILLS

  - Mastering a specific job task/procedure
- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheets 1 & 2.

JOB SHEET 1

SERVICING DRUM BRAKES

II

OBJECTIVE 13

Remove, clean, and visually inspect brake drums.

INTRODUCTION

When a brake has been in use long enough for its lining to wear out, its drum usually has some defects, too. Because a cast iron brake drum wears at a much slower rate than the lining that contacts it, there may be the temptation to ignore the drum unless there is some obvious defect. But to yield to this temptation shows that the importance of the drum is not understood, and the result is an imperfect repair job.

If you know what to look for, you will find many common defects while inspecting brake drums. Brake drums must be removed from the vehicle before they can be inspected or refinished. Use the following procedure to remove, clean, and inspect brake drums.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- EPA-approved asbestos safety equipment and recommended protective clothing
- Hydraulic lift or jack and jack stands
- Fender and seat covers
- Chisel
- Ball-peen hammer
- Diagonal cutting pliers
- Dust cap removing tool or channel-lock pliers
- Chalk or marker
- Lug wrench
- Sockets to fit lug bolts
- Rubber mallet
- Approved brake-cleaning solvent
- Shop towels
- Brake adjustment tool (brake spoon)
- Brake System Inspection Report Form

◆ WARNING ◆

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Used approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Functional Writing Skills
- Complete forms and records

NOTE: Be sure to note all inspection findings on your Brake System Inspection Report Form.

1. Cover fenders and seats.
2. Raise vehicle and support safely.
3. Remove wheel cover.
4. On each rear wheel, mark lug hole and corresponding lug bolt.

   NOTE: This is necessary in order to preserve tire balance upon reassembly.

5. Remove rear wheels and set aside.
6. Mark each drum next to the marked lug, also indicating *left* and *right* to preserve balance during reassembly.

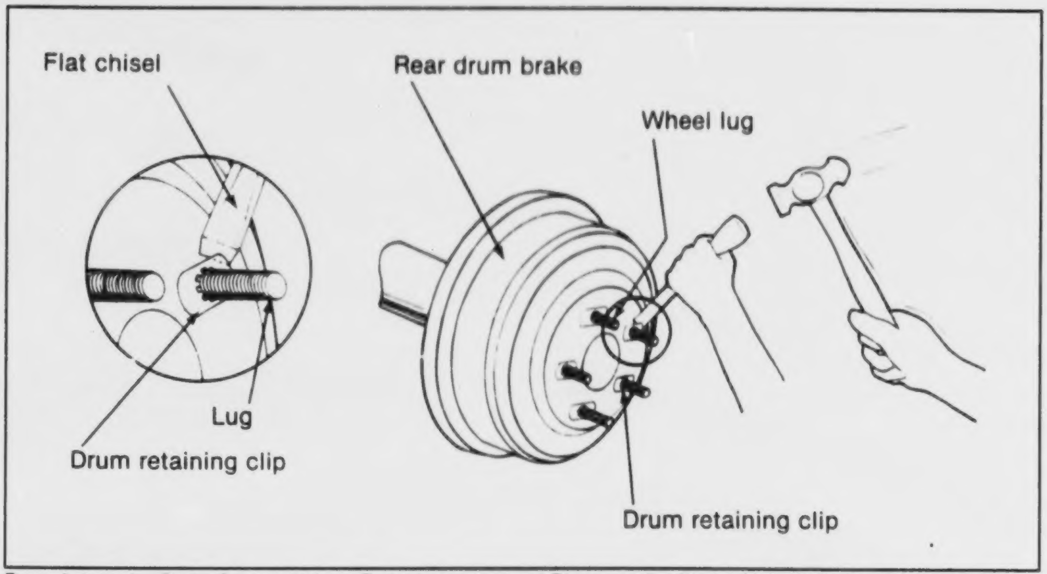
PROCEDURE

Job Acquisition/ Development Skills
- Master specific job task/ procedure
- Practice good work habits/attitudes

Remove brake drums from a rear-wheel drive vehicle

1. Make sure that parking brake is released.
2. Use small, flat chisel and ball-peen hammer to loosen drum retaining clips as shown in Figure 1, taking care not to damage threads on wheel lugs when prying clip away from drum.

FIGURE 1


Flat chisel
Rear drum brake
Wheel lug
Lug
Drum retaining clip
Drum retaining clip

From *Automotive Brake Service, Unit 1: Brake Inspection and Diagnosis,* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

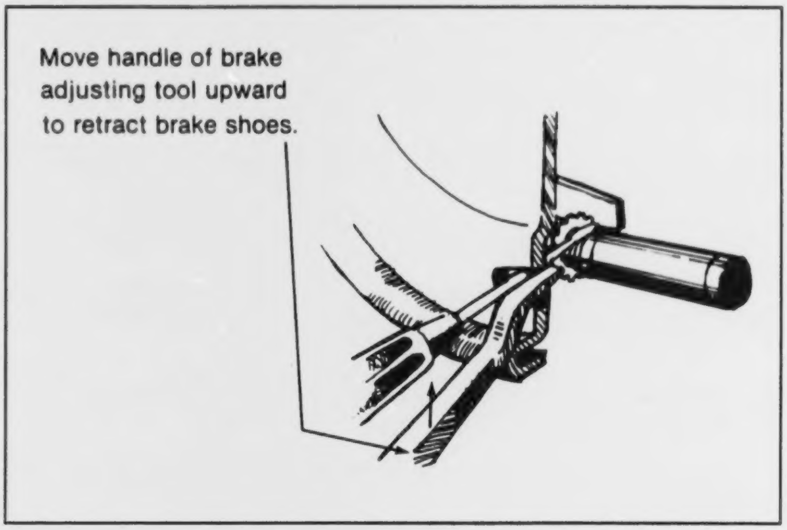
3. Grasp each clip with diagonal cutting pliers and pull away from drum and off lug; discard clips.

   NOTE: Drum retaining clips are usually found only on vehicles that have never had the drums removed. The clips do not need to be reinstalled or replaced.

4. Grasp drum with both hands and pull it out and away from axle.

5. If drum moves out slightly but will not pull freely off axle, back off brake shoe adjustment as shown in Figure 2 and detailed in service manual.

FIGURE 2


Move handle of brake adjusting tool upward to retract brake shoes.

6. If rust has formed between drum and axle, causing drum to stick to axle flange, tap drum between lugs with hammer to break it loose.

PROCEDURE

Remove brake drums from front-wheel drive vehicles

NOTE: On vehicles with front-wheel-drive and rear drum brakes, the procedure for removing the rear drums may differ from that for removing rear-wheel-drive drums. Most front-wheel-drive vehicles have a rear drum setup.

1. Using dust cap removing tool or channel-lock pliers, remove dust cap, taking care not to damage it.
2. Using diagonal cutting pliers, straighten ends of cotter pin, pry it out of hole in spindle, and discard pin.
3. Remove nut lock, spindle nut, and washer.
4. Remove outer cone-and-roller assembly.
5. Grasp brake drum with both hands and pull it out and away from axle.
6. If drum moves out slightly but will not pull freely off axle, back off brake shoe adjustment as shown in Figure 2.

7. If rust causes drum to stick to axle flange, tap drum between wheel lugs with hammer to break it loose.

PROCEDURE

Clean and inspect brake drums

1. Clean disassembled brake assemblies and drums with approved brake-cleaning solvent following directions on solvent container.

2. Visually inspect each drum for cracks, scoring, and hot spots.

   NOTE: If drum is cracked, it must be replaced; if drum is scored, it must be refinished. Hot-spots cannot usually be removed by refinishing, and drums must be ground or replaced.

3. Continue to Job Sheet 2 to complete inspection.

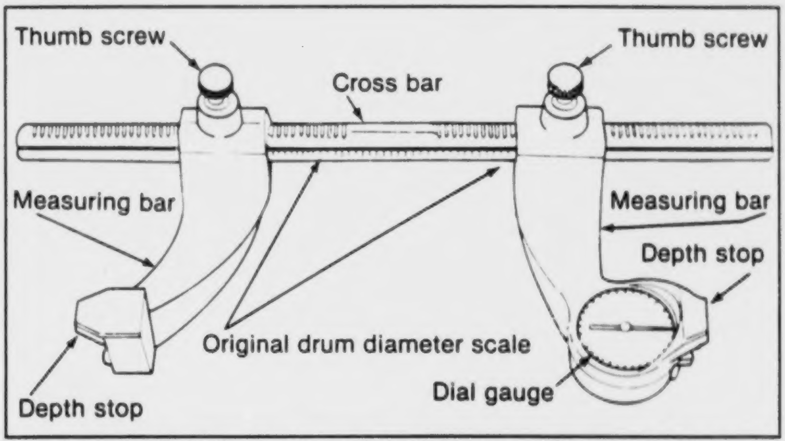
SERVICING DRUM BRAKES

OBJECTIVE 14 **Measure and refinish brake drums.**

INTRODUCTION

There are some drum defects that cannot be detected without the use of a brake drum micrometer, an instrument that measures the diameter of a brake drum in thousandths of an inch. There are many types of brake drum micrometers, but most are similar to the one shown in Figure 1.

FIGURE 1



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A drum brake lathe can be used to correct some brake drum defects by refinishing the brake drum. The lathe is also used to machine new brake drums to ensure that the new drums will be perfectly round when installed.

Other defects cannot be properly corrected by refinishing, and the drums can only be replaced. Visual inspection findings may indicate that brake drum replacement is necessary—cracked or broken drums must be replaced. Brake drums need to be replaced if they are oversized or if they will be oversized as a result of refinishing drums to correct defects or problems. Most manufacturers specify an acceptable maximum diameter of the brake drum after refinishing that is usually at least .030 inch less than the specification for maximum (discard) diameter. This allows for no more than .030 inch after refinishing for normal drum wear. Generally, if a drum is more than .060 inch over its original diameter, it cannot bear refinishing and must be discarded.

Another defect which cannot be corrected by using a lathe is hot spots. They can only be removed by grinding, and then they may reappear after grinding. It is usually recommended that a drum with hot spots be replaced.

Some defects which should be looked for and which may be corrected by refinishing (if brake drum diameter after refinishing does not exceed the manufacturer's specified maximum diameter) are listed below.

- Barrel shape
- Eccentric (off center)
- Bell mouth
- Taper
- Scoring
- Out-of-round (runout)

NOTE: If runout is excessive, the drum must be replaced; consult vehicle service manual for maximum runout specifications.

There are many different types of drum lathes in use, and the specific operating instructions vary with each design. For this reason, you should study the manual furnished with the lathe before attempting to refinish the brake drums. You must continue to wear eye protection at all times until final reassembly of brake assembly is complete.

EQUIPMENT AND MATERIALS

- Equipment and materials listed in Job Sheet 1
- Brake drum micrometer
- Drum brake lathe, appropriate adapters and accessories, and manual

♦ WARNING ♦

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Used approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Math Application Skills
- Use English and metric measures

Measure brake drums

1. Find maximum diameter marking on drum and set drum micrometer to this original diameter.

   NOTE: American automobile manufacturers commonly use drums of even-inch or half-inch sizes. You will find drums that measure 9, 10, and 11 inches. You will also find some that measure 9½ inches, 10½ inches, and other half-inch sizes. If you are unable to find the diameter marking on the drum, consult the vehicle service manual.

2. Insert micrometer into drum and push it down until its depth stops hit edge of drum.

   NOTE: If depth stops on micrometer are adjustable, position the micrometer so that it measures the widest distance across drum, such as when drum is bell-mouthed or tapered. If stops are not adjustable, be aware that measurement may not accurately reflect these conditions.

3. With micrometer held in place, move one end back and forth in a slight arc until dial shows highest obtainable reading.

4. Find exact diameter of drum by adding this reading to diameter to which you set micrometer and record findings.

5. Repeat steps 2-4 to measure other drum from same axle.

PROCEDURE

General Science Skills
- Use scientific instruments

Refinish brake drum

1. Replace the drum if it is oversize or if the refinishing required to correct the defect will make the drum oversize.

   CAUTION

   Any drum that is over the maximum diameter is unsafe and must be replaced rather than refinished.

Job Acquisition/ Development Skills

- Master specific job task/procedure
- Practice good work habits/attitudes

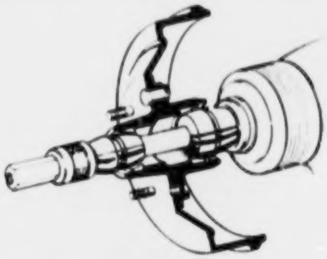
NOTE: If drum does not meet specifications and must be replaced, most manufacturers recommend that a light machining cut be made on all new drums. This is because the cast iron drums can become distorted during storage. The cut ensures that the new drums will be perfectly round when you install them.

2. Continue procedure to refinish if it appears that the problem can be corrected without making the drum oversize.

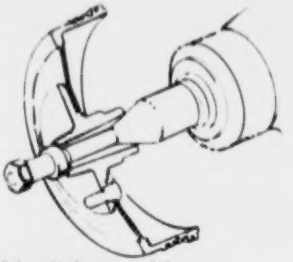
3. Mount drum on lathe, following procedure outlined in lathe manual for type of drum you are working with.

   NOTE: Three common types of brake drums each mounted on a lathe are illustrated in Figure 2.

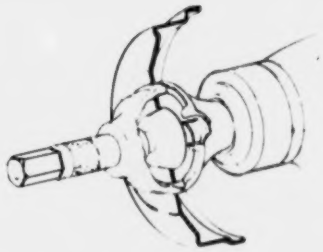
FIGURE 2



Hubbed drum with bearings and races



Hubbed drum with splined or tapered holes



Front- or rear-wheel floating drum

Used with permission of AMMCO TOOLS, Inc.

4. Check accuracy of your mounting by turning cross slide handwheel inward (clockwise) to move tool bit away from surface of drum.

5. Turn feed handwheel so that tool bit is positioned inside drum about 1 inch from its outer edge.

6. Make sure that feed lever is in NEUTRAL and turn on lathe.

7. While drum is rotating, slowly turn cross slide handwheel outward (counterclockwise) until tool bit barely touches surface of drum.

8. Turn off lathe.

9. Examine drum surface.

10. If drum surface is perfectly round, the tool bit will have made a mark completely around drum; if this is the case, continue to step 17.

11. If tool mark does not run completely around drum, drum is out-of-round, eccentric, or improperly mounted.

12. Loosen arbor nut and rotate drum on arbor one-half turn.

13. Tighten arbor nut and move feed handwheel slightly so that tool bit moves to one side of original mark.

14. Turn on lathe so that tool bit makes a second mark.

15. Turn off lathe and examine drum; if second mark is alongside the first, the drum is out-of-round or eccentric and your mounting is accurate; if the marks are not side by side, the drum was inaccurately mounted.

16. If drum was inaccurately mounted, repeat steps 12 through 15 until you make a tool mark that is alongside the one made just before.

17. Install drum silencing band by stretching it around circumference of drum, making sure that it contacts all parts of outer surface of drum.

    NOTE: The drum silencing band is used to dampen or silence vibrations that may be set up in the drum when it is being machined. If the drum vibrates when it is being refinished, the vibrations cause it to move in and out creating a rough surface called a herringbone pattern. A herringbone pattern on the finished surface of the drum causes rapid lining wear as it actually files away the lining. It will also cause brake pull and erratic braking.

18. Turn on lathe, and turn feed handwheel so that tool bit is drawn out toward edge of drum to cut into and remove "rust ridge" present at open edge of drum.

19. Turn feed handwheel back so that bit moves back into drum, continuing to turn wheel until bit starts to enter inner corner of drum.

CAUTION

Proceed slowly here because there is usually another ridge in the corner.

20. Continue turning handwheel slowly until bit cuts away inner ridge and reaches inner edge of drum surface.

21. Note setting on dial of cross slide handwheel; advance it .005 inch to push bit into drum surface.

22. Lock cross slide so that your adjustment will not change.

23. If lathe has a feed speed dial, adjust it to 16 to provide a relatively fast cut; if lathe has two speeds, shift feed into fast-cut or rough-cut position.

24. Lock your adjustment and engage the feed lever.

25. When cut is finished and tool bit is clear of drum, disengage feed lever and turn off lathe.

26. Inspect drum surface; if defects still exist, start lathe and turn feed handwheel to run lathe back into corner; if defects are corrected, continue to step 30.

27. Loosen lock on cross slide and advance handwheel another .005 inch.

28. Engage feed lever for another fast cut.

29. Repeat fast cuts of .005 inch until all defects are eliminated.

30. Run tool bit back into corner of drum and advance cross feed handwheel .002 inch.

31. If lathe has a feed speed dial, adjust it to 2; if lathe has two speeds, shift feed lever into slow-cut or fine-cut position.

32. Lock your adjustment and engage feed lever.

33. When cut is finished and tool bit is clear of drum, disengage feed lever and shut off lathe.

34. Visually inspect drum surface; surface should be smooth to the eye and touch.

35. Remove drum from arbor and remove silencing band from drum.

36. Measure drum with micrometer to make sure that its diameter does not exceed greatest allowable oversize after machining.

    NOTE: This is usually .060 inch.

37. Repeat steps 3 through 36 to mount and refinish second drum, machining it to within .015 inch of first.

38. Clean newly refinished drums.

    NOTE: The friction surface of a newly refinished drum contains millions of tiny metal particles. These particles not only remain free on the drum surface, but lodge themselves in the open pores of the surface. If these metal particles are allowed to remain in the drum, they become embedded in the brake lining. Once the brake lining is contaminated in this way, it acts as a fine grinding stone and scores the drum.

    ♦ WARNING ♦

    Do not attempt to clean the drum of metal particles by blowing out the drum with air pressure. The tiny metal particles in the drum can be harmful to your health.

39. Remove wheel bearings and grease seals from hub, if applicable.

    CAUTION

    If front hubs and drums area being cleaned, be very careful to avoid contamination of wheel bearing grease. Or, completely remove all old grease, then regrease and repack wheel bearings after drum has been washed and dried.

40. Wash brake drum thoroughly with hot water, wipe with lint-free rag, and thoroughly dry with air pressure; or, wipe inside of brake drum with lint-free rag dipped in approved brake-cleaning solvent and allow to dry before reinstallation.

41. Clean work area and return equipment and materials to proper storage or continue to the next Job Sheet as directed by your instructor.

JOB SHEET 3 SERVICING DRUM BRAKES II

OBJECTIVE 15 **Remove, clean, and inspect brake shoes and related hardware.**

INTRODUCTION

Each time the brakes on a moving vehicle are applied, a slight amount of brake lining is worn away. Depending on the type of use to which the vehicle is subjected and the skills of the driver, brake lining life will average 20,000 miles to 40,000 miles. The inspection of the brake lining is an important part of routine maintenance. A worn lining can decrease the effectiveness of braking and may cause an accident. Not only is a worn lining dangerous, it can cause excessive drum wear, requiring replacement of these parts.

Because of the variety of drum brake mechanisms and hardware, the Brakes Specialist must refer to the appropriate service manual when removing brake shoes, linings, and related hardware. Some guidelines, however, are general to the procedure, and those are listed below.

- Always use EPA-approved asbestos safety equipment and recommended protective clothing.

  ◆ WARNING ◆

  Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Used approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

- Do not disassemble both drum brake assemblies at the same time. Perform all of the procedures to remove, clean, and replace the brake shoes on one side of the vehicle before you disassemble the other side. Working this way ensures that you will reassemble the brakes properly, since you can always refer to the position of the parts on the assembled side.

- If you will not be rebuilding or replacing the wheel cylinder as part of brake shoe replacement procedure, install a wheel cylinder clamp as sown in Figure 1 on the following page to prevent the pressure that remains in the hydraulic system from pushing the wheel cylinder pistons and cups too far out in the bore when you remove the brake shoe retracting springs.

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

Math Application Skills
- Use English and metric measure

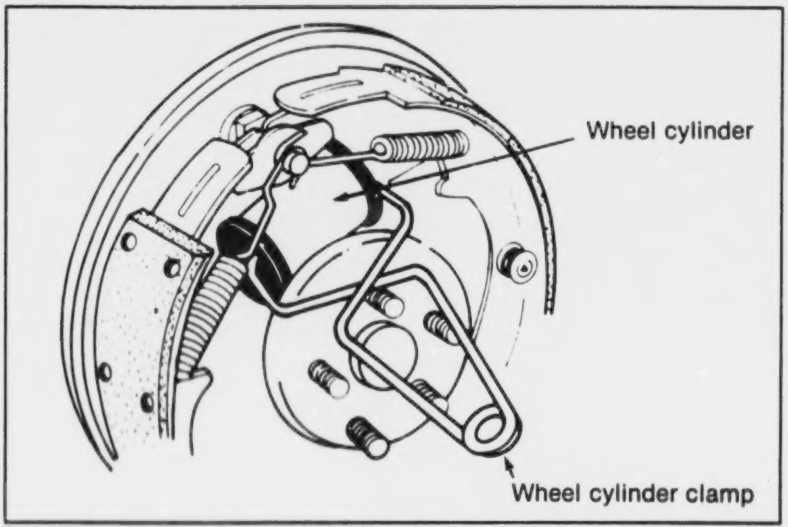
Functional Math Skills
- Make measurements

General Science Skills
- Use scientific instruments

Job Acquisition/ Development Skills

- Master specific job task/procedure

FIGURE 1



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- As you remove the brake hardware, place the parts on the workbench in the same positions they were on the backing plate. Also note the color, shape, and size of the various parts. This procedure will help you differentiate parts that look almost alike, such as the secondary and primary retracting springs and the automatic adjusting spring.

- Since the removed shoes and their linings will be exchanged with reconditioned shoes and new linings, do not attempt to clean the removed shoes.

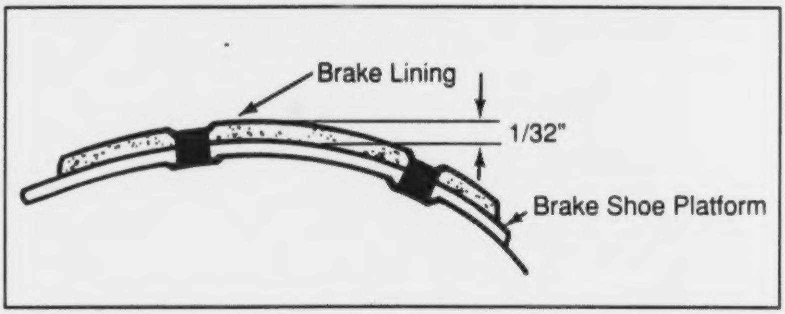
- If any shoe retracting spring needs to be replaced, you must replace *both* primary and secondary shoe retracting springs on both wheels of the axle to ensure equal braking action.

- Unless you plan to rebuild or replace the wheel cylinder, leave the pushrods in position in the center of the wheel cylinder dust boots. Keeping the pushrods in place will prevent contaminants from entering the wheel cylinder when you clean the backing plate.

- When cleaning the backing plate, take care not to get excess solvent around the dust boots of the wheel cylinder as it could contaminate the brake fluid and damage the rubber parts.

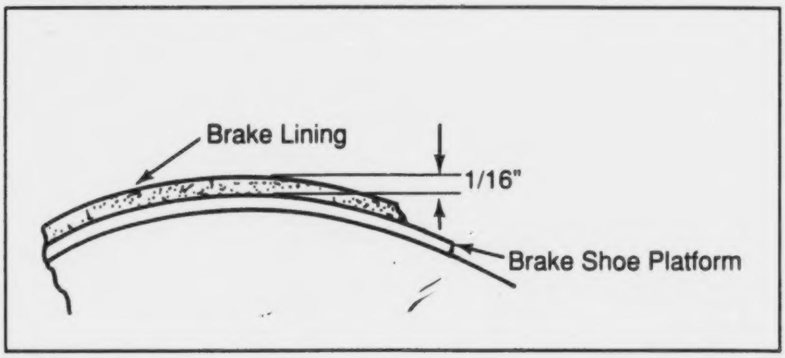
- Contaminated linings must be replaced, and the cause of the contamination should be located and repaired. If linings at one wheel require replacement, the linings of the other wheel of the same axle must also be replaced to obtain equal braking.
- Inspect linings for wear, using specifications in service manual and illustrations below for guidelines.
- Replace riveted lining (Figure 2) if it is worn to less than 1/32 inch over heads of rivets.

FIGURE 2



- Replace bonded lining (Figure 3) if it is worn to less than 1/16 inch thickness.

FIGURE 3



EQUIPMENT AND MATERIALS

- Appropriate service manual
- Other equipment and materials as required by procedure

PROCEDURE

NOTE: Refer to the appropriate service manual for make and model as equipped.

JOB SHEET 4

SERVICING DRUM BRAKES

OBJECTIVE 16

Remove, recondition, and reinstall a wheel cylinder.

INTRODUCTION

When inspecting a wheel cylinder, an inexperienced person may flip back the lower end of each boot and, if there is no appearance of fluid, assume that the cylinder does not need to be serviced. However, as the brake linings wear, the pistons and cups move farther outward within the bore. As they move outward, contamination is introduced into the bore. When the new shoes are installed, the system will remain contaminated unless the cylinder is reconditioned or replaced. Contaminants will cause quicker wear of the wheel cylinder assembly, which may result in internal leakage.

Reconditioning the wheel cylinder may include refinishing the cylinder bore walls if they are scratched or scored. However, there are limitations on honing the cylinder bore. For example, the cylinder bore should not be increased by more than .002 inch, and aluminum wheel cylinders cannot be honed and must be replaced.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- EPA-approved asbestos safety equipment and recommended protective clothing
- Hydraulic lift or jack and jack stands
- Fender and seat covers
- Lug wrench
- Sockets to fit lug bolts
- Brake bleeding equipment
- Box wrench or brake bleeder wrench
- Feeler gauge
- Brake cylinder hone
- Electric drill motor
- Open-end wrench set
- Channel-lock pliers
- Diagonal cutting pliers
- Crocus cloth
- Lint-free shop cloths
- Tubing wrenches
- Torque wrench
- Clean, approved brake fluid
- Recommended lubricant
- Denatured alcohol

- Shop towels
- Line plugs or caps
- Rubber mallet
- Replacement parts as necessary
- Penetrating oil

◆ WARNING ◆

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Used approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

General Science Skills
- Use scientific instruments

Remove a wheel cylinder

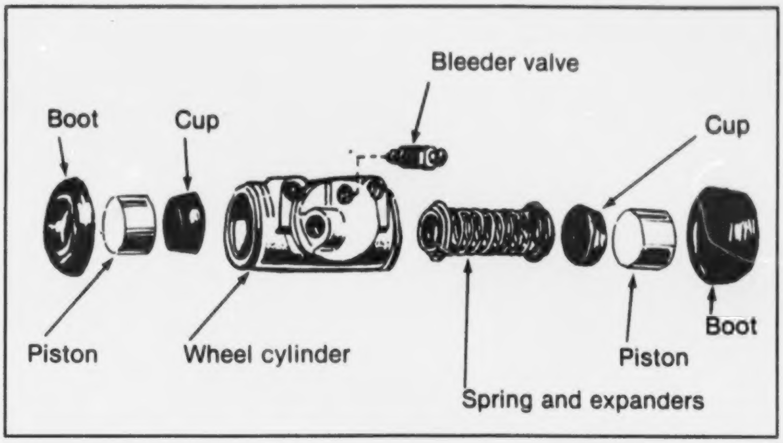
1. Cover fenders and seats.
2. Raise vehicle and support safely.
3. Remove tire-and-wheel assembly and brake drum assembly. (Job Sheet 1)
4. Remove brake shoes. (Job Sheet 3)
5. Disconnect brake line from wheel cylinder, taking care to prevent twisting line.
6. Plug or cap ends of line to prevent contamination.
7. Inspect brake lines; if lines are defective, discard and replace with new during reinstallation.
8. Remove wheel cylinder attaching bolts.
9. Remove wheel cylinder from backing plate.

Job Acquisition/ Development Skills

- Master specific job task/ procedure
- Practice good work habits/attitudes

10. Disassemble wheel cylinder using Figure 1 below for reference.

FIGURE 1



11. Remove bleeder valve screw from cylinder with six-point socket or brake bleeder wrench.

    NOTE: If bleeder valve is seized in the cylinder, the cylinder must be replaced; if a cylinder's bleeder screw cannot easily be removed, the system cannot be bled.

12. Remove wheel cylinder actuating pins.

13. Remove wheel cylinder boots.

14. Push out pistons, cups, spring, and expanders.

PROCEDURE

Recondition a wheel cylinder

1. Clean all reusable metal parts with clean, approved brake fluid.

   NOTE: Rubber parts such as cups and boots are not reusable and should be replaced with new ones.

2. Inspect pistons for scratches, scoring, or corrosion; if pistons are pitted or show signs of wear, replace.

3. Inspect bleeder valve for defective threads or dirt; if threads are defective, replace valve with new valve; if dirty, clean with brake fluid.

4. Inspect wheel cylinders bore for scratches, scoring, and discoloration.

5. If cylinder bore is discolored or stained, polish with crocus cloth.

   NOTE: This is best accomplished by covering your finger with crocus cloth, then inserting into cylinder and twisting finger.

6. If cylinder bore walls are scratched or scored, clamp in vise and recondition with cylinder hone.

   CAUTION

   The cylinder bore should not be increased by more than .002 inch. A cylinder that requires honing beyond .002 inch should be replaced. See manufacturer's recommendations.

7. Secure cylinder in vise by clamping supporting bracket of cylinder in vise or by wrapping cylinder with cloth and clamping cylinder in vise. See Figure 2.

   NOTE: Tighten vise only enough to secure cylinder. Overtightening may result in damage, such as abrasions, to cylinder body.

8. Pass a lint-free cloth through bore several times to remove any loose contamination.

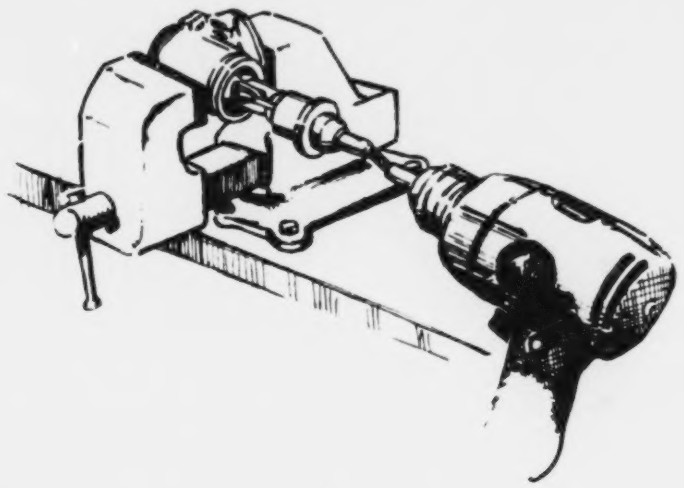
9. Dip hone stones in clean brake fluid and attach to drill motor.

10. Insert hone in cylinder bore and turn on drill motor; rotate and polish bore. (Figure 2)

    CAUTION

    Take care not to allow the stones of the hone to slip out of the bore during this step as damage to the stones would result.

FIGURE 2



11. Wash inside of bore with denatured alcohol and dry with compressed air.

12. Using a suitable light, inspect interior of bore for signs of dark areas, indicating a depression in the surface; if bore is not polished along full length of travel of pistons and cups, replace wheel cylinder with new one.

13. Determine if bore's diameter is oversize by installing pistons in cylinder bore.

14. Measure cylinder bore diameter and select appropriate feeler gauge. (Table 1)

Math
Application Skills
- Use English and metric measures

TABLE 1

If cylinder bore diameter is —	Feeler gauge thickness should be —
¾ inch to 13/16 inch	.006 inch
1¼ to 1 7/16 inch	.007 inch
1½ inch	.008 inch

Data Analysis and Display Skills
- Interpret charts and tables

Functional Math Skills
- Make measurements

15. Attempt to insert feeler gauge; if gauge enters bore, wheel cylinder is not usable and must be replaced.

16. Remove pistons.

17. Blow out passage for bleeder valve with compressed air.

18. Coat threads of bleeder valve with recommended lubricant.

19. Install and tighten valve.

PROCEDURE

Reinstall a wheel cylinder

1. Coat cups, pistons, and cylinder bore with clean brake fluid.

2. Install expanders on spring as required.

3. Install spring and expanders into wheel cylinder, taking care not to scratch cylinder bore.

4. Install new cups positioned with lips toward center of cylinder, taking care not to damage cup lips during installation.

5. Install pistons, positioned with flat ends toward center of cylinder.

6. Install new boots, making sure that boot lips are seated in grooves at ends of cylinder.

7. Install cylinder push rods if applicable.

8. Reinstall wheel cylinder on backing plate, torquing bolts or anchor pin to manufacturer's specifications.

9. Remove plugs or caps from brake line and reinstall brake line on wheel cylinder, taking care to avoid cross-threading.

10. Reinstall brake shoes and drums, following procedure in service manual.

11. Manually bleed brake system at required wheel cylinder.

12. Check master cylinder fluid level and refill with clean, approved brake fluid to at least three-quarters full if necessary.

CAUTION

Take care not to spill brake fluid on any chrome or painted surfaces at it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

13. Reinstall tire-and-wheel assembly, tightening lug nuts in a cross pattern just enough so that wheel is snug against hub.

14. Lower vehicle to floor.

15. Torque lug nuts to manufacturer's specifications.

16. Install wheel covers, tapping in place with rubber mallet.

17. Road test vehicle.

♦ WARNING ♦

Before test driving any vehicle, check the fluid level in the master cylinder and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

18. Clean work area and return equipment and materials to proper storage or proceed to the next job sheet as directed by your instructor.

JOB SHEET 5

SERVICING DRUM BRAKES

II

OBJECTIVE 17

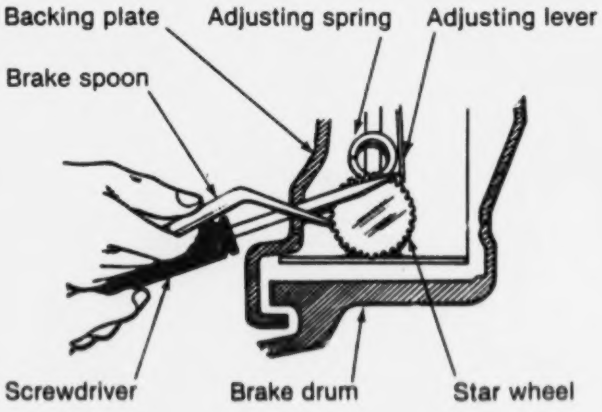
Adjust brake shoes and reinstall shoes, related hardware, and drums or drum/hub assemblies.

INTRODUCTION

Modern brake designs incorporate the drum brake self-adjusting mechanism. Brakes that feature this self-adjusting mechanism may never require a minor adjustment; the brake is designed to adjust itself. However, the self-adjusting mechanism may fail, requiring a check and adjustment of the mechanism as well as a manual adjustment of the lining-to-drum clearance. The Brakes Specialist must be able to make these types of adjustments.

MANUAL BRAKE SHOE ADJUSTERS

Modern drum brakes are designed with devices that adjust the position of the brake shoes to the drum. This adjustment is necessary because the shoes wear during use. To make up for this wear, the adjusters slowly push the shoes outward as they wear. This maintains throughout the life of the shoes approximately the same distance between the shoes and the drums when the brakes are not applied. Although automatic adjusters work in various ways, most are activated when the brakes are applied while the vehicle is backing. But it is also sometimes necessary to be able to adjust brake shoes manually. This may be required to free the drum so that it can be removed or to position newly installed drums or as a result of other service. The illustration below shows one method of manually adjusting brake shoes. One tool is used to hold down a release mechanism while another is used to turn the star wheel, which moves the shoes. Although the design of the automatic adjusting mechanism varies greatly from one vehicle to another, the manual adjustment procedure in the illustration is typical of many vehicles. Service manuals explain how to adjust brakes manually on specific vehicles and may provide detailed adjustment guidelines for particular procedures.



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The following procedure is applicable for most vehicles that have drum brakes with star wheel adjusters. However, some vehicles with star wheel adjusters will use slightly different procedures, and other vehicles without star wheel adjusters will use a completely different procedure.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

EQUIPMENT AND MATERIALS

- Equipment and materials listed in Job Sheets 1 and 3
- Drum-to-shoe gauge

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

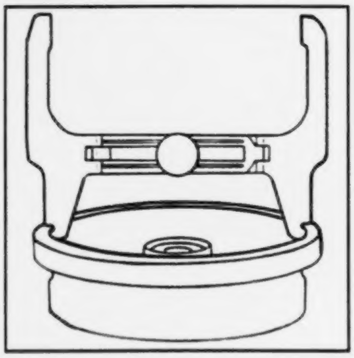
Math Application Skills
- Use English and metric measures

Functional Math Skills
- Make measurements

1. Remove, clean, and inspect brake drums and shoes. (Job Sheets 1 and 3)
2. Reassemble brake assembly, following instructions in service manual.
3. Check mechanism for broken or improperly installed parts.
4. Hold adjusting lever out of engagement with star-wheel adjusting screw and rotate star-wheel adjusting screw to make sure that it is free turning.
5. Adjust lining-to-drum clearance by inserting gauge into drum and adjusting the inside caliper part of gauge to drum diameter. (Figure 1)

   NOTE: You may have to loosen the parking brake adjustment in order to complete the lining-to-drum adjustment.

FIGURE 1



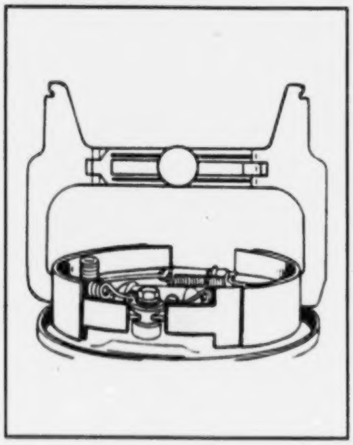
General Science Skills
- Use scientific instruments

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

6. Lock the gauge.

7. Remove gauge from drum and place outside caliper part of gauge across centers of shoes. (Figure 2)

FIGURE 2



8. Expand star wheel by hand until shoes just touch gauge.

   NOTE: The drum-to-shoe gauge is designed to provide a lining-to-drum clearance of .010 inch.

9. Rotate gauge around shoes to check setting.

10. Install each drum in its original position on vehicle, making sure to align each marked lug and lug hole.

11. Bleed brake system.

12. Check parking brake adjustment and adjust as necessary. (Job Sheet 6)

13. Install rear tire-and-wheel assemblies, making sure that they are in their original positions and tightening lug nuts in a cross pattern just enough so that wheel is snug against hub.

14. Lower vehicle to floor.

15. Torque lug nuts to manufacturer's specifications.

16. Install wheel covers, tapping in place with rubber mallet.

17. Road test vehicle.

    ◆ WARNING ◆

    Before test driving any vehicle, check the fluid level in the master cylinder and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

18. Clean work area and return equipment and materials to proper storage or proceed to the next job sheet as directed by your instructor.

JOB
SHEET 6

SERVICING DRUM BRAKES

II

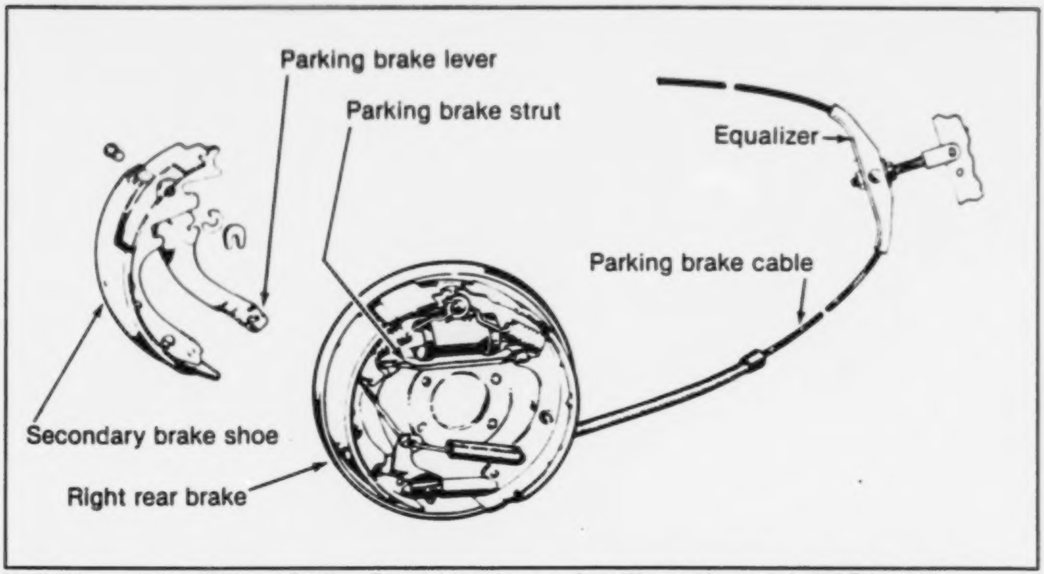
OBJECTIVE 18

Adjust an integral parking brake.

INTRODUCTION

Figure 1 below shows the components of a typical integral parking brake removed from the wheel brake for easy identification.

FIGURE 1


Parking brake lever
Parking brake strut
Equalizer
Parking brake cable
Secondary brake shoe
Right rear brake

Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600/Feb., 1984.*

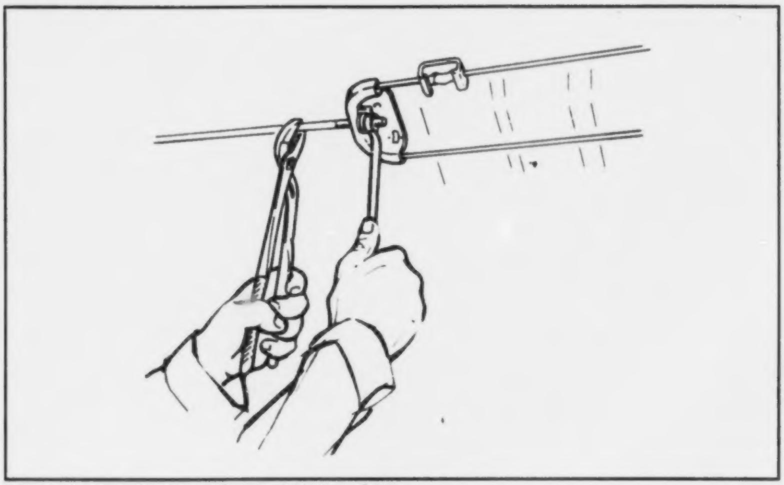
Functional Reading Skills
- Interpret graphics and symbols

Although specific cable adjustments depend on the vehicle model, only simple tightening adjustments are needed to take up the slack caused by cable stretch and/or shoe wear. (Figure 2) Adjustment is done at the equalizer. If the front cable must be adjusted, do this first. Then engage the operating lever at least one notch before adjusting rear cables. This helps avoid overtightening, which would expand the brake shoes into contact with the drum and cause rear wheel drag.

Research and Reference Skills
- Use standard references

Job Acquisition/ Development Skills
- Master specific job task/procedure

FIGURE 2



Used with permission of General Motors Corp.

Remember the following guidelines when adjusting an integral parking brake.

- It may be necessary to hold the front cable to prevent it from turning.
- After making adjustment, make sure that both check nuts (if two are used) are tight against equalizer.
- After adjustment, always apply and release parking brake several times to test operation.
- With parking brake released, make sure that there is no drag on the rear wheels.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Other equipment and materials as required by procedure

PROCEDURE

NOTE: Refer to appropriate service manual for make and model as equipped.

JOB SHEET 1

Remove, clean, and visually inspect brake drums.

Student's name ______________________ Date ________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed brake drums from rear-wheel-drive vehicle following outlined procedure.	___	___
3. Removed brake drums from front-wheel-drive vehicle following outlined procedure.	___	___
4. Cleaned and inspected brakes following outlined procedure.	___	___
5. Observed safety rules and precautions.	___	___
6. Correctly filled out Brake System Inspection Report Form.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4	**Skilled** - Can perform job with no additional training
3	**Moderately Skilled** - Has performed job during training program; limited additional training may be required
2	**Limited Skill** - Has performed job during training program; additional training is required to develop skill
1	**Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 2 — SERVICING DRUM BRAKES — II

JOB SHEET 2

Measure and refinish brake drums.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Measured brake drums with micrometer following outlined procedure.	___	___
3. Correctly determined whether to refinish or replace each drum.	___	___
4. Refinished drum following outlined procedure.	___	___
5. Measured and cleaned drum after refinishing.	___	___
6. Observed safety rules and precautions.	___	___
7. Correctly filled out Brake System Inspection Report Form.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 3

Remove, clean, and inspect brake shoes and related hardware.

Student's name ______________________ Date ________

Evaluator's name ______________________ Attempt no. ___

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Disassembled drum brake assemblies correctly.	___	___
3. Inspected shoes, linings, and related hardware following procedure outlined in vehicle manufacturer's service manual.	___	___
4. Correctly determined if any parts needed to be replaced	___	___
5. Cleaned appropriate parts following procedure outlined in vehicle manufacturer's service manual.	___	___
6. Observed safety rules and precautions.	___	___
7. Correctly filled out Brake System Inspection Report Form.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standard	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

SERVICING DRUM BRAKES

JOB SHEET 4

Remove, recondition, and reinstall a wheel cylinder.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed and disassembled wheel cylinder following outlined procedure.	___	___
3. Cleaned and inspected wheel cylinder components following outlined procedure.	___	___
4. Reconditioned cylinder bore following outlined procedure.	___	___
5. Reassembled and reinstalled wheel cylinder following outlined procedure.	___	___
6. Observed safety rules and precautions.	___	___
7. Correctly filled out Brake System Inspection Report Form.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 5

SERVICING DRUM BRAKES

II

JOB SHEET 5

Adjust brake shoes and reinstall shoes, related hardware, and drums or drum/hub assemblies.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed, cleaned, and inspected brake drums and shoes.	___	___
3. Inspected self-adjusting mechanism following outlined procedure.	___	___
4. Adjusted lining-to-drum clearance following outlined procedure.	___	___
5. Properly reinstalled drums.	___	___
6. Observed safety rules and precautions.	___	___
7. Correctly filled out Brake System Inspection Report Form.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 6

Adjust an integral parking brake.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Properly prepared vehicle.	___	___
3. Adjusted integral parking brake following procedure outlined in vehicle manufacturer's service manual.	___	___
4. Completed service correctly.	___	___
5. Observed safety rules and precautions.	___	___
6. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

____

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specification.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

SERVICING DRUM BRAKES

Name ______________________________ Score ________

OBJECTIVE 1

Recognize definitions of terms associated with drum brakes by choosing the correct definitions from lists of three choices. Write the letter of the correct definition in the blank.

_____ 1. **dissipate**

a. To disintegrate or make disappear
b. To integrate or dissolve
c. To break up and scatter; to disperse or make disappear

_____ 2. **drum brake**

a. Brake design in which a friction block contacts outer circumference of wheel to produce braking action
b. Brake design in which an external band of flexible steel lined with friction material wraps around drum or hub and is tightened by application of brake pedal
c. Brake design in which curved brake shoes press against inner circumference of a rotating metal drum to produce braking action

_____ 3. **eccentric**

a. Disc or lobe (cam) used to convert rotary action to reciprocating action; off-center
b. Disc or lobe (cam) used to convert static to kinetic energy; egg-shaped
c. Disc or lobe (cam) used to convert rotary to linear action; wallowed

_____ 4. **flange**

a. Arm pivoted so that its free end can fit into a detent, slot, or groove to hold a part stationary
b. Projecting lip, rim, or edge
c. Device that prevents leakage at wheel cylinders

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_____ 5. **honing**

a. Removing metal with a fine abrasive stone
b. Sharpening metal with a fine abrasive stone
c. Scoring metal with a fine abrasive stone

_____ 6. **labyrinth seal**

a. Seal formed by wheel hub and drum rim that prevents water splashed from the road from entering the brake mechanism
b. Seal formed by wheel cylinder piston and cylinder boot that prevents water splashed from the road from entering the brake mechanism
c. Seal formed by backing plate flange and drum rim that prevents water splashed from the road from entering the brake mechanism

_____ 7. **pawl**

a. Projecting lip, rim, or edge
b. Brake valve that prevents leakage at wheel cylinders
c. Arm pivoted so that its free end can fit into a detent, slot, or groove to hold a part stationary

_____ 8. **primary shoe**

a. In non-servo brakes, that shoe toward front of forward-moving vehicle
b. In servo brakes, that shoe toward front of forward-moving vehicle
c. In servo brakes, that shoe toward rear of forward-moving vehicle

_____ 9. **recondition**

a. To machine or return a part to its original surface condition
b. To disassemble, clean, replace defective parts, and reassemble a component or assembly
c. To replace a component or assembly with one of the original diameter or state

May be photocopied for student use

_____10. **residual valve**

a. Device that reduces pressure to rear wheels during braking

b. Device that maintains pressure in the system after brake pedal is released to prevent leakage at wheel cylinders

c. Device that allows air or liquid to pass in one direction only

_____11. **secondary shoe**

a. In non-servo brakes, that shoe toward front of forward-moving vehicle

b. In servo brakes, that shoe toward rear of forward-moving vehicle

c. In non-servo brakes, that shoe toward rear of forward-moving vehicle

_____12. **self-adjusting**

a. Process of compensating for shoe wear by automatically adjusting lining thickness

b. Process of compensating for shoe wear by automatically adjusting shoe-to-lining clearance

c. Process of compensating for shoe wear by automatically adjusting shoe-to-drum clearance

_____13. **self-energizing**

a. Use of friction to force brake shoes tighter against linings

b. Use of primary shoe to help apply secondary shoe

c. Use of friction to force one brake shoe tighter against drum

_____14. **servo action**

a. Process that results when both shoes are free to swing into drum, and primary shoe helps apply secondary shoe

b. Process that results when one side is energized and other shoe is de-energized

c. Process that results when both shoes are free to swing into drum, and secondary shoe helps apply self-adjusting mechanism

May be photocopied for student use.

OBJECTIVE 2

Recall uses of specialty tools used to service drum brakes by writing the correct use when given the name of a specialty tool. Write the correct uses for each of the following drum brake service specialty tools in the blank following the name of the tool.

1. **drum brake adjusting spoon** — ____________________

   ____

   ____

2. **brake spring pliers** — ____________________

   ____

   ____

3. **hold-down spring tool** — ____________________

   ____

   ____

4. **drum brake lathe** — ____________________

   ____

   ____

5. **enclosure-type brake cleaner** — ____________________

   ____

   ____

6. **drum-to-shoe gauge** — ____________________

   ____

   ____

7. **retracting spring (brake spring) tool** — ____________________

   ____

   ____

May be photocopied for student use.

8. **wheel cylinder clamp** — ______________________

____

____

9. **brake cylinder hone** — ______________________

____

____

10. **bleeder screw wrench** — ______________________

____

____

11. **drum brake micrometer** — ______________________

____

____

OBJECTIVE 3

Recall steps in drum brake operation by listing the steps in correct sequence. Write the steps in the blanks.

1. ______________________________

____

____

2. ______________________________

____

____

3. ______________________________

____

____

May be photocopied for student use.

4. ______________________________

____

____

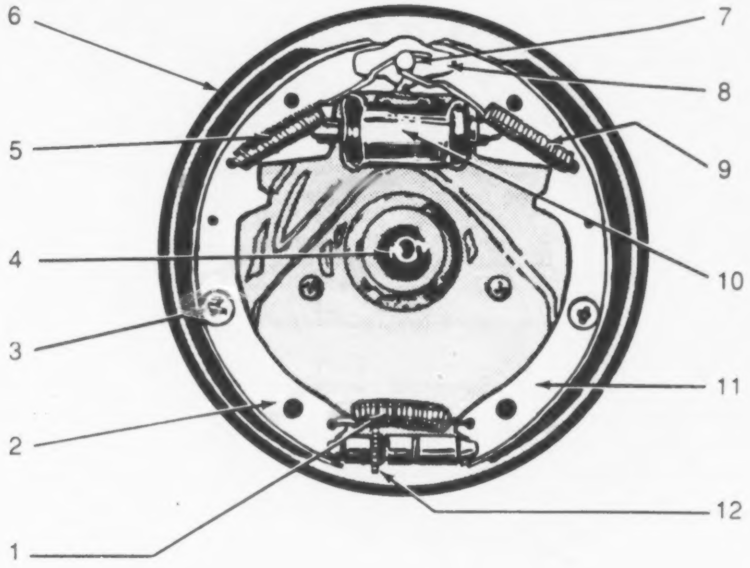
5. ______________________________

____

____

OBJECTIVE 4 **Recall components of typical duo-servo and non-servo brake assemblies by labeling the components shown on an illustration.** Write the name of the components indicated on the illustrations in the corresponding blanks.

Duo-servo assembly



← Front of car

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1. ______________________ 7. ______________________

2. ______________________ 8. ______________________

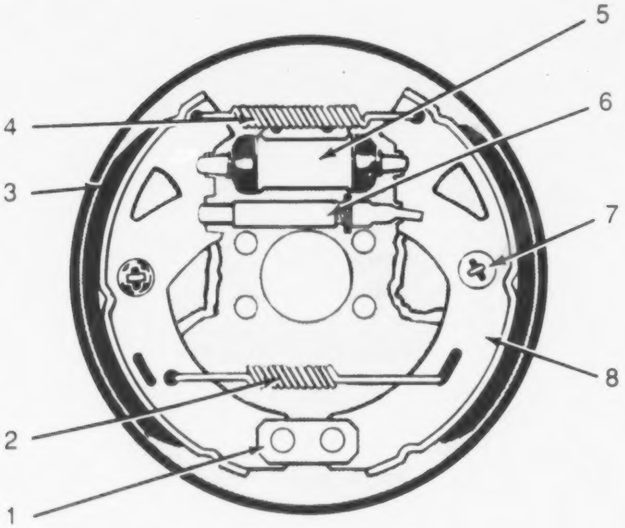
3. ______________________ 9. ______________________

4. ______________________ 10. ______________________

5. ______________________ 11. ______________________

6. ______________________ 12. ______________________

Non-servo assembly



←
Front of car

1. ______________________ 5. ______________________

2. ______________________ 6. ______________________

3. ______________________ 7. ______________________

4. ______________________ 8. ______________________

May be photocopied for student use.

OBJECTIVE 5

Recognize the functions of components of a duo-servo brake assembly by matching components to their correct functions. Write the letter of the correct component in the blank.

______ 1. Provides mounting surface for lining

______ 2. Holds all of the brake parts except the drum

______ 3. Pushes shoes farther apart as lining wears

______ 4. Pulls shoes away from drum when brakes are released

______ 5. Holds shoes flat against backing plate

______ 6. Pushes brake shoes out into contact with drum

______ 7. Prevents shoes from turning with the brake drum

______ 8. Contacts drum and provides friction necessary for braking action

______ 9. Holds shoes together at star wheel adjuster

a. backing plate

b. anchor pin

c. hold-down assembly

d. retaining spring

e. star wheel adjuster

f. wheel cylinder

g. retracting spring

h. brake shoe

i. brake lining

OBJECTIVE 6

Recognize definitions of terms associated with brake drum problems by matching terms to their correct definitions. Write the letter of the correct term in the blank.

______ 1. Having enlarged or misshapen hole due to wear or rubbing

______ 2. Condition of no longer being perfectly round or true

______ 3. Curved outward

a. carbonizing

b. concave

c. convex

d. concentric

May be photocopied for student use.

_____ 4. Curved inward

_____ 5. Twisted out of shape or changed from usual or normal shape

_____ 6. Forcing material out of its regular shape or condition by high-pressure rubbing

_____ 7. Having a common center

_____ 8. Severe overheating of an object resulting in a change of the material content

_____ 9. Having shiny, glass-hard resin deposits on surface

_____10. Loss of braking friction caused by excessive heat

_____11. Turned or bent to one side

_____12. Not having a common center; out-of-round

e. deflection
f. distorted
g. eccentric
h. fade
i. galling
j. glazed
k. wallowed
l. warpage

OBJECTIVE 7

Recall defects to look for when visually inspecting drum brake components by listing defects for given component names. List at least 3 defects for each component.

1. **Brake lining**

- ________________________________
- ________________________________
- ________________________________

May be photocopied for student use.

2. **Drum**

   - ____________________
   - ____________________
   - ____________________

3. **Backing plates**

   - ____________________
   - ____________________
   - ____________________

4. **Shoe retainer and spring nail assemblies**

   - ____________________
   - ____________________
   - ____________________

5. **Retaining springs**

   - ____________________
   - ____________________
   - ____________________

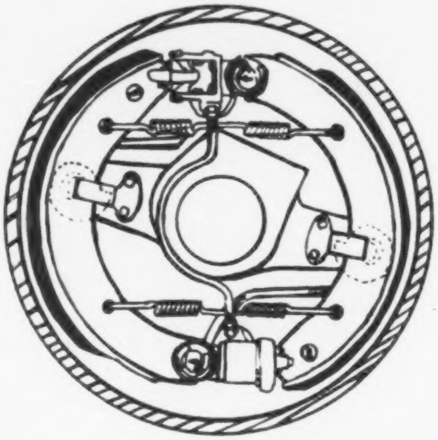
6. **Automatic adjuster assemblies**

   - ____________________
   - ____________________
   - ____________________

May be photocopied for student use.

OBJECTIVE 8

Recall common types of brake shoe mountings by writing the correct names for given illustrations. Write the type of brake shoe mounting in the blank under each illustration.



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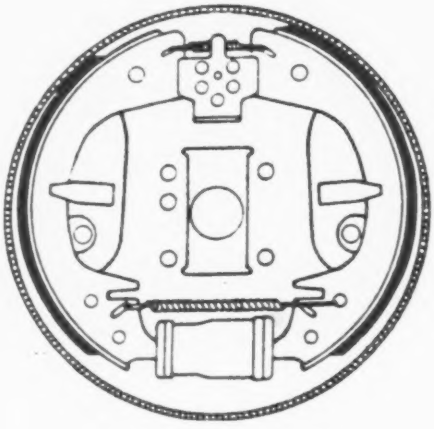
1. ______________________________



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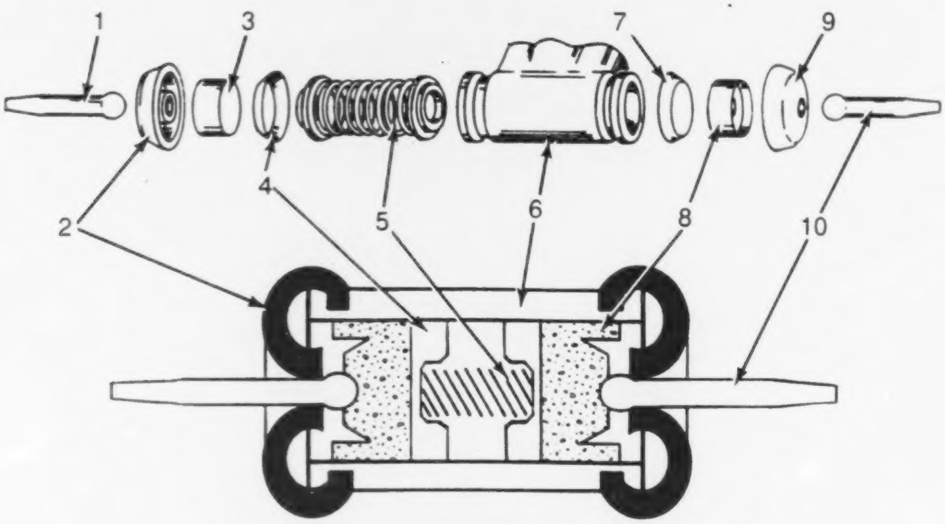
2. ______________________________

May be photocopied for student use.

OBJECTIVE 9

Recall basic components of a typical wheel cylinder by writing the names of components shown on an illustration. Write the correct names in the blanks.

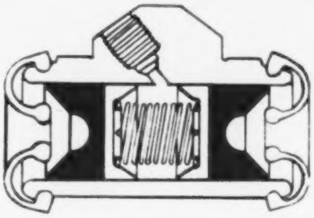


1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________

May be photocopied for student use.

OBJECTIVE 10

Recall types of wheel cylinders used with drum brakes by writing the correct names for given illustrations. Write the correct name in the blank below the illustration.



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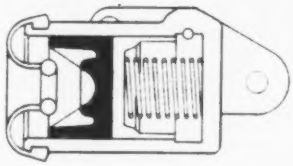

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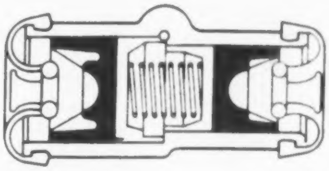

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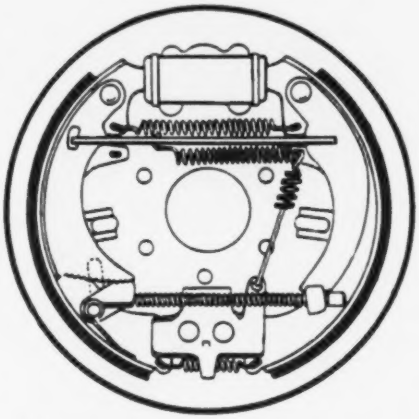
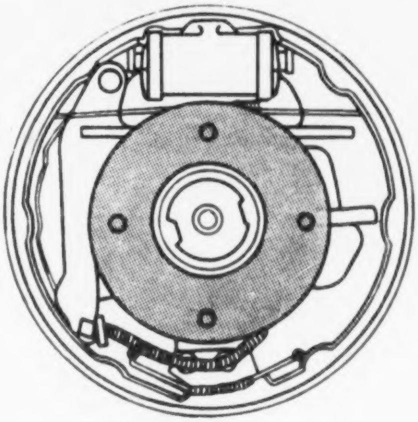
OBJECTIVE 11 **Recognize types of automatic drum brake shoe adjusters by labeling illustrations with the correct names.** Choose the correct name from the list and write it in the blank below the illustration.

Link (crank)
Rod-and-strut assembly
Cable
Eccentric cam
Ratchet
Lever



Used with permission of Ford Motor Co.

1. ______________________________



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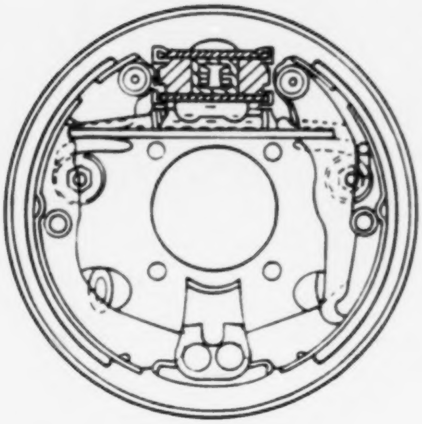
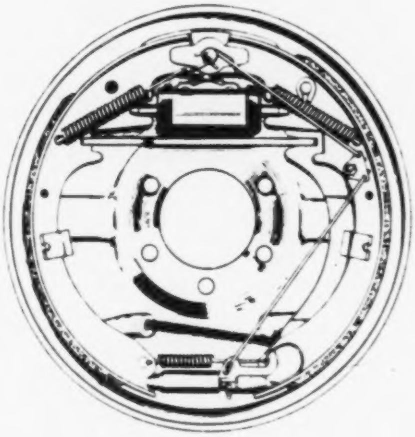


Used with permission of Allied Aftermarket.

3. ______________________________



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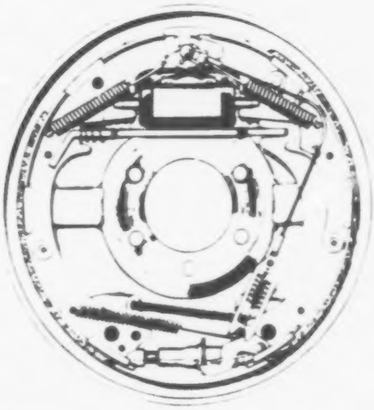

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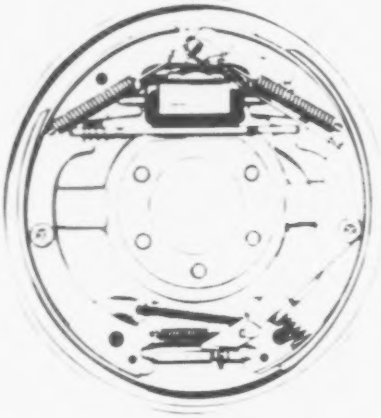

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6. ____

May be photocopied for student use

WRITTEN TEST ANSWERS

SERVICING DRUM BRAKES

II

OBJECTIVE 1

1. c
2. c
3. a
4. b
5. a
6. c
7. c
8. b
9. a
10. b
11. b
12. c
13. c
14. a

OBJECTIVE 2

1. Used to back off star wheel for drum removal or for adjustment of lining-to-drum clearance
2. Used to remove and reinstall retracting and adjusting springs
3. Used to remove and reinstall hold-down springs
4. Used to machine the friction surface of brake drums
5. Used to clean brake lining dust from brake assembly; designed to protect technician from harmful asbestos fibers
6. Used to measure and adjust lining-to-drum clearance
7. Used to pry springs off anchor pin for removal and to stretch springs over anchor pin for reinstallation
8. Used to prevent hydraulic pressure from pushing wheel cylinder pistons and cups too far out in bore when brake shoe retracting springs are removed
9. Used to recondition wheel cylinder bore
10. Used to open and close wheel cylinder bleeder screws
11. Used to measure drum diameter

OBJECTIVE 3

1. Brake pedal is depressed, generating hydraulic pressure in master cylinder.
2. Hydraulic pressure from master cylinder is transmitted to wheel cylinder.
3. Wheel cylinder pistons push brake shoes against rotating drum.
4. Shoes try to rotate with drum, producing a wedging action that helps press the linings into firmer contact with drum.
5. Friction between brake shoe and brake drum slows or stops rotation of wheel.

OBJECTIVE 4

Duo-servo assembly

1. Retaining spring
2. Primary shoe
3. Hold-down assembly
4. Spindle
5. Primary shoe retracting spring
6. Backing plate
7. Anchor pin
8. Anchor plate
9. Secondary shoe retracting spring
10. Wheel cylinder
11. Secondary shoe
12. Star wheel adjuster

Non-servo assembly

1. Anchor
2. Retaining spring
3. Forward shoe
4. Retracting spring
5. Wheel cylinder
6. Star wheel adjuster
7. Hold-down cup and spring
8. Reverse shoe

OBJECTIVE 5

1. h
2. a
3. e
4. g
5. c
6. f
7. b
8. i
9. d

OBJECTIVE 6

1. k
2. l
3. c
4. b
5. f
6. i
7. d
8. a
9. j
10. h
11. e
12. g

OBJECTIVE 7

Answers should include at least three defects for each test item.

1. Cracks, glazing, fluid or grease contamination, uneven wear
2. Hot spots, scoring, cracking, out-of-round, oversize
3. Cracks or warpage, pads for ridges, pads for steps, lack of lubrication.
4. Wallowing of retainer holes, loose springs, improper installation of spring nails or retainers
5. Overheating, stretching, distortion, nicks
6. Missing or damaged parts, improper installation, frayed adjusting cables, rounded-off star wheels, damaged cable guides, damaged adjusting levers, frozen adjusting screws

OBJECTIVE 8

1. Double-anchor double cylinder
2. Single-anchor self-centering

OBJECTIVE 9

1. Brake-shoe actuating pin
2. Boot
3. Piston
4. Piston cup
5. Spring and expanders
6. Wheel brake cylinders body
7. Piston cup
8. Piston
9. Boot
10. Brake shoe actuating pin

OBJECTIVE 10

1. Double-piston straight-bore
2. Single-piston
3. Double-piston step-bore

OBJECTIVE 11

1. Ratchet
2. Rod-and-strut assembly
3. Eccentric cam
4. Link (crank)
5. Cable
6. Lever

OBJECTIVE SHEET

SERVICING DISC BRAKES

III

INTRODUCTION

Many different brake systems are used by today's automobile manufacturers. While the majority of today's American automobiles have front disc brakes and rear drum brakes, some late-model General Motors and Chrysler automobiles and a number of foreign models are equipped with four-wheel disc brakes.

Disc brakes are generally used on the front wheels because they have more braking force than drum brakes. Disc brake calipers convert brake fluid pressure and volume into a clamping force. The clamping force of the front-wheel brakes provides 60 to 85 percent of the total stopping torque of the vehicle.

PREREQUISITES

Before studying this unit, the student should have successfully completed Unit 2, *Servicing Drum Brakes*.

UNIT OBJECTIVE

After completing this unit, the student will be able to diagnose disc brake problems and service disc brake systems. The Student will demonstrate these competencies by completing the assignment sheet, job sheets, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to:

1. Recognize definitions of terms associated with disc brakes by choosing the correct definitions from lists of three choices.
2. Recall specialty tools used to service disc brakes by writing the name of the tool when given an illustration.

3. Recall the steps of disc brake operation by listing the steps in order when given a numbered illustration.

4. Recall descriptions of types of disc brake calipers by writing the correct descriptions of each.

5. Recall the parts of a typical floating caliper assembly by labeling the parts of an illustration.

6. Recall the advantages of disc brake design by writing the advantages.

7. Recognize types of parking brakes used on vehicles with rear disc brakes by matching illustrations of types of parking brakes to their correct descriptions.

8. Diagnose disc brake problems. (Assignment Sheet)

9. Remove, clean, inspect, and reinstall caliper assembly and brake pads. (Job Sheet 1)

10. Recondition a disc brake caliper. (Job Sheet 2)

11. Clean, inspect, and measure a rotor with dial indicator and micrometer. (Job Sheet 3)

12. Resurface a rotor. (Job Sheet 4)

13. Overhaul and adjust rear disc/drum (auxiliary drum) parking brake. (Job Sheet 5)

14. Overhaul Kelsey-Hayes type rear disc brake/parking brake assembly. (Job Sheet 6)

15. Overhaul GM Delco-Moraine type rear disc brake/parking brake assembly. (Job Sheet 7)

SERVICING DISC BRAKES

PREPARATION

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the Delivery section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special needs students.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the Suggested Resources section. Include in your selection media that demonstrate Job Sheet skills. Videotape your own demonstrations of Job Sheet procedures if unable to obtain suitable media.

- Obtain Competency Profiles for this unit.

  NOTE: Competency Profiles for this book are available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364; 1-800-522-5810, ext. 589 in-state; 1-800-654-4502 out-of-state.

- Prepare classroom and shop. Display posters, charts, safety signs, etc., related to disc brake service. Have articles, specification guides, mock-ups, component displays, and other disc brake service resource material available for student reference. Display various disc brake calipers and related hardware.

- The Written Test should be given as a pretest so that identified competencies can be accurately measured.

- Use the section in the Upfront to assist you in assessing student competencies.

- Consider the pretest results as you prepare your presentation for each objective.

DELIVERY

- Discuss introduction to the unit in the Objective Sheet.
- Discuss the Unit Objective and then the specific objectives. Emphasize how accomplishing the specific objectives will lead to meeting the unit objective and how reaching the unit objective is vital to becoming a Brakes Specialist. Also relate the objectives to your introduction and to materials previously covered.
- Discuss the evolution of disc brakes and show the filmstrip, *Disc Brake Service*, as an overview of the unit.
- Use Transparency 1, Major Components of a Disc Brake System, to introduce students to the typical components of a tandem dual brake system with rear drum and front disc brakes.
- Display Bendix *Brake System Schematic* and Thiokol wall chart and use to supplement your discussion of disc brakes as applicable.
- Review asbestos safety, stressing the absolute necessity for avoiding inhalation of asbestos particles.
- Tour the shop, pointing out equipment and materials used in servicing disc brakes.

Objective 1: Recognize definitions of terms associated with disc brakes by choosing the correct definitions from lists of three choices.

- Point out examples in the shop of appropriate terms and make examples available in the classroom.
- Show samples of various types of disc brakes.
- Show students examples of scoring and scuffing.
- Show students the vane on a ventilated disc brake. Discuss how the vanes on such a brake help to dissipate heat.
- Show students the locations of inboard and outboard shoes.
- Illustrate the term *friction* by having students rub their thumb and index fingers together without and then with a drop of oil applied. Use sandpaper and a soft substance to illustrate how friction causes wear.

- Discuss the boxed material presented with this objective.

Objective 2: Recall specialty tools used to service disc brakes by writing the name of the tool when given an illustration.

- Show students an example of each of the tools listed in this objective and demonstrate the use of each of the tools, allowing students to repeat the demonstration.
- Show students a drum brake lathe and demonstrate how it can be adapted for machining disc brakes.
- Show students an enclosure type brake cleaner and review its installation and its importance in asbestos containment.
- Discuss the care and maintenance of each tool and show students the proper shop storage location for each of the tools. Stress the need for returning tools to proper storage.
- Where applicable, show students alternative tools that may be used to accomplish a task.

  EXAMPLE: Using channel-lock pliers to remove a dust cap

Objective 3: Recall the steps of disc brake operation by listing the steps in order when given a numbered illustration.

- Discuss braking action in general, reviewing hydraulic principles and friction.
- Make a mock-up so that students may view the sequence of disc brake operation.
- Discuss disc brake operation on four-wheel disc brake vehicles.
- Provide students with AC-Delco brochures, *Four Piston Disc Brakes* and *Single Piston Disc Brakes.*
- Compare disc brake shoe action to the braking action that occurs on a ten-speed bicycle.
- Use Transparency 1, Major Components of a Disc Brake System, to illustrate your discussion of disc brake operation.

Objective 4: Recall descriptions of types of disc brake calipers by writing the correct descriptions of each.

- Show students examples of each type of caliper illustrated in this objective.
- Point out that caliper names indicate the movement allowed or disallowed by the mounting technique.
- Use Transparencies 2 through 4 to illustrate your discussion.
- Discuss reasons for single- and multiple-piston designs.
- Provide students with technical bulletin *Disc Brake Caliper Assemblies* for future reference.
- Provide students with Extensions and Options 1, Types of Disc Brake Caliper Assemblies. Discuss with the class.

Objective 5: Recall the parts of a typical floating caliper assembly by labeling the parts on an illustration.

- Display a disassembled floating caliper assembly and allow students to examine its components.
- Show students a floating caliper assembly mounted on a vehicle.
- Use Transparency 2, Parts of a Floating Caliper Disc Brake Assembly, to point out the parts of the floating caliper disc brake assembly.
- Provide students with technical bulletin, *Disc Brake Caliper Assemblies*, for future reference.
- Refer to Extensions and Options 1, Types of Disc Brake Caliper Assemblies, and discuss those that are of the floating caliper design.

Objective 6: Recall the advantages of disc brake design by writing the advantages.

- Review and discuss the advantages of disc brake design.
- Discuss the boxed material, *Disc Brake Design Features.*

- Show students how the design of the disc brake makes it more resistant than the drum brake to heat and water fade.

- Discuss the correct use of an inspection report form such as Extensions and Options 2, Brake System Inspection Report Form, or similar form, and provide students with copies for them to use while practicing inspection procedures.

Objective 7: Recognize types of parking brakes used on vehicles with rear disc brakes by matching illustrations of types of parking brakes to their correct descriptions.

- Show students examples of each type of parking brake on various makes and models of vehicles.

- Display disassembled examples of each type of parking brake. Name and discuss each of the components to familiarize students with the parts of each.

- Use Transparencies 5 through 7 to illustrate your discussion of parking brake types.

- Provide students with examples of vehicles equipped with these types of parking brakes.

  EXAMPLE: All Corvettes since 1965 and some Camaros and Imperials since 1974 have four-wheel disc brakes and auxiliary drum parking brakes.

APPLICATION

DIAGNOSIS SKILLS

Diagnosis is the highest level of competence in automotive service. Any type of automotive diagnosis requires that the technician possess both extensive knowledge and considerable practical skill. In this series, the Assignment Sheets are designed to help the student learn the diagnostic skills involved in using troubleshooting procedures and diagnostic charts commonly found in vehicle service manuals. These skills are only part of the total requirements for diagnostic excellence.

DIAGNOSIS SKILLS (CONTINUED)

We recognize that a good diagnosis cannot be made without the practical knowledge the student will learn from performing the Job Sheet tasks. At the same time, the job Sheet procedures should not be performed unless the necessity for them is indicated by a proper diagnosis. You will need to analyze your teaching techniques and decide whether to have your students do the Assignment Sheets before the Job Sheets or vice versa. For students who are newly learning these skills, there are pitfalls to both sequences.

Objective 8: Diagnose disc brake problems. (Assignment Sheet)

- Provide the students with Lee *Disc Brake Troubleshooting Guide* and Niehoff *Diagnosing Brake Squeal* bulletins to use as diagnostic references.
- Have the students use the Supplement, Troubleshooting Chart for Disc Brakes, to complete the Assignment Sheet.

Objective 9: Remove, clean, inspect, and reinstall caliper assembly and brake pads. (Job Sheet 1)

- Discuss the equipment and materials used in Job Sheet 1.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet Introduction.
- Review the asbestos safety rules and the installation of the brake cleaner.
- Show and discuss the video, *Repairing Sliding Caliper Disc Brake*, from the series, *Service Disc Brakes*.
- Demonstrate Job Sheet 1.
- Have the students practice Job Sheet 1 until they are ready to take the Practical Test.

Objective 10: Recondition a disc brake caliper. (Job Sheet 2)

- Discuss the equipment and materials used in Job Sheet 2.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet Introduction.
- Demonstrate caliper bore honing techniques.
- Demonstrate Job Sheet 2.
- Have the students practice Job Sheet 2 until they are ready to take the Practical Test.

Objective 11: Clean, inspect, and measure a rotor with dial indicator and micrometer. (Job Sheet 3)

- Discuss the equipment and materials used in Job Sheet 3.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet Introduction.
- Allow the students to practice using a dial indicator and a micrometer.
- Demonstrate Job Sheet 3.
- Have students practice Job Sheet 3 until they are ready to take the Practical Test.

Objective 12: Resurface a rotor. (Job Sheet 4)

- Discuss the equipment and materials used in Job Sheet 4.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet Introduction.
- Demonstrate how to adapt a drum lathe for disc brake use.
- Demonstrate Job Sheet 4.
- Have the students practice Job Sheet 4 until they are ready to take the Practical Test.

Objective 13: Overhaul and adjust rear disc/drum (auxiliary drum) parking brake. (Job Sheet 5)

- Discuss the equipment and materials used in Job Sheet 5.

- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet Introduction.
- Show and discuss the video, *Automotive Tech Series: Servicing Parking Brakes.*
- Demonstrate Job Sheet 5.
- Have the students practice Job Sheet 5 until they are ready to take the Practical Test.

Objective 14: Overhaul Kelsey-Hayes type rear disc brake/parking brake assembly. (Job Sheet 6)

- Discuss the equipment and materials used in Job Sheet 6.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet Introduction.
- Demonstrate Job Sheet 6.
- Have the students practice Job Sheet 6 until they are ready to take the Practical Test.

Objective 15: Overhaul GM Delco-Moraine type rear disc brake/parking brake assembly. (Job Sheet 7)

- Discuss the equipment and materials used in Job Sheet 7.
- Review the applicable safety rules and precautions and the guidelines given in the Job Sheet Introduction.
- Demonstrate Job Sheet 7.
- Have the students practice Job Sheet 7 until they are ready to take the Practical Test.

EVALUATION

- Give the Written Test

  NOTE: The Written Test may be given in sections if desired.

- Many multiple-choice test questions (in the Activity Sheets, Assignment Sheets, and Written Test) for this curriculum have been written in a style that is similar to the questions on the ASE certification test. Like ASE questions, the student should select the item that **BEST** answers the question. *The student should make no additional assumptions about a question other than those specifically given in the question.* A special effort has been made to provide good distracters for each question which will make the student think through the answer. It is suggested that the instructor review the answers to every test before reviewing the test with the students so that he or she is not caught off guard by such distracters.

- Evaluate the class on the Assignment Sheet activities if not previously done.
- Give the Practical Tests, providing students with copies of Extensions and Options 2, Brake System Inspection Report Form, or similar form to be completed as part of the Practical Tests. Evaluate the tests on the forms provided.
- Reteach and retest as required.
- The Activity Sheets may be given at the end of the unit as a review and a preview of the ASE test style.
- Complete the appropriate section of the Competency Profiles.
- Review individual and group performance in order to evaluate teaching methods.
- Adjust the scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Resources used in developing unit.

- *Automotive Brake Service, Unit 1: Brake Inspection and Diagnosis.* Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Automotive Brake Service, Unit 2: Front Disc Brake Service.* Tallahassee, Florida: State of Florida Department of Education, 1981.
- *Basic Car Care*, 2nd ed. New York: Hearst Corporation, 1980.
- *Bendix Service Manual 8-400: Domestic and Import Car Brake Service Manual.* Jackson, Tennessee: Bendix Aftermarket Brake Division, n.d.

- Billiet, Walter E., and Walter Alley. *Automotive Suspensions, Steering, Alignment, and Brakes*, 5th ed. Alsip, Illinois: American Technical Publishers, Inc., 1982.
- *Chilton's Auto Repair Manual 1985: Domestic and Canadian Cars from 1978 through 1985.* Radnor, Pennsylvania: Chilton Book Company, 1984.
- Coghlan, David A. *Automotive Chassis Systems: Steering, Suspension, Alignment, and Brakes*, 2nd ed. Boston: Breton Publishers, A Division of Wadsworth, Inc., 1985.
- Crouse, William H., and Donald L. Anglin. *Automotive Mechanics*, 9th ed. New York: Gregg Division, McGraw-Hill Book Company, 1985.
- Henderson, Chuck, and Ivan Armstrong. *Auto Mechanics I.* Stillwater, Oklahoma: Oklahoma Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1976.
- Hughes, James G. *Guide to Automobile Certification Examination*, revised ed. Reston, Virginia: Reston Publishing Company, Inc., a Prentice-Hall Company, 1983.
- *Mitchell Chassis Service & Repair Domestic Cars: 1985 Supplement.* San Diego, California: Mitchell Information Services, Inc., a Cordura Company, 1985.
- *1986 Chrysler Engine-Chassis-Body Manual: 1986 Front Wheel Drive Passenger Vehicles: Lancer, Daytona, New Yorker, Dodge 600, Aries, Omni, LeBaron GTS, LeBaron, Caravelle, Reliant, Horizon.* Centerline, Michigan: Chrysler Corporation, 1985.
- *1986 New Model Highlights and Service Features: Domestic and Import.* Centerline, Michigan: Chrysler Corporation Service and Parts Operations, Training Program Development Department, 1985.
- *1986 Shop Manual: Caprice, Monte Carlo, El Camino.* Detroit, Michigan: General Motors Corporation, Chevrolet Motor Division, 1986.
- *Raybestos Brake Service Manual for Passenger Cars: Drum and Disc Brakes.* Bridgeport, Connecticut: Division of Raybestos Manhattan, 1970.

- Remling, John. *Brakes*, 2nd ed. New York: John Wiley and Sons, Inc., 1978.

- Stockel, Martin W., and Martin T. Stockel. *Auto Mechanics Fundamentals*. South Holland, Illinois: Goodheart-Willcox Company, Inc. 1982.

- Toboldt, William K., and Larry Johnson. *Automotive Encyclopedia: Fundamental Principles, Operation, Construction, Service, Repair*. South Holland, Illinois: the Goodheart-Willcox Company, Inc., 1983.

- *Wagner Manual AU-1600/Feb., 1984: Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual*. Parsippany, New Jersey: Wagner Division, McGraw-Edison Company, 1984.

- *Wagner Manual AU-1600: Hydraulic Disc and Drum Brake Diagnostic Analysis and Reconditioning Manual*. Parsippany, New Jersey: Wagner Division, Cooper Industries, Inc., 1988.

Media

Spelling and definitions of terminology used in automotive service are not standardized. Media selected to supplement and reinforce materials taught in this book may or may not use the same spelling and definitions. Although such deviations should not restrict classroom use of supplemental materials, its existence may confuse some students.

- *Automotive Tech Series: Caliper Overhaul*. 37 minutes, VHS, Beta 1 or Beta 2 videotapes.

- *Automotive Tech Series: Using the Disc and Drum Micrometer*. 27 minutes, VHS, Beta 1 or Beta 2 videotapes.

- *Automotive Tech Series: Servicing Parking Brakes*. 10-15 minutes, VHS, Beta 1 or Beta 2 videotapes.

- GM X-Body Brake Service, *Disc Brakes: Removal* and *Disc Brakes: Assembly*. 2 cassettes, 2 filmstrips, and instructor's guide.

- *Disc Brake Service.* 1 filmstrip, 1 cassette.

  NOTE: These first five media presentations are available from Teaching Aids Incorporated, Post Office Box 1798, Costa Mesa, California 92628-0798.

- *The Hydraulic Brake System Explained: How to Reline Disc-Type Brakes.* 7-14 minutes VHS videotape.

- *The Hydraulic Brake System Explained: Servicing the Hydraulic System—Disc Type.* 7 minutes each, VHS videotapes. Available from National Innovative Media Company, Route 2, Box 301B, Calhoun, Kentucky 42327, call toll-free 800-962-6662. These media may also be obtained as filmstrips and cassettes.

- *Drum and Disc Brake Service.* 24 minutes, 113 slides/audio. Available from Wagner Division, McGraw-Edison Company, 6400 Plymouth Avenue, St. Louis, Missouri 63133.

- *Service Disc Brakes.* Videotape, color, includes *Repair Sliding Caliper Disc Brake* and *Check Disc Runout and Thickness.* Available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364.

  NOTE: The following two sound filmstrips are part of a series titled *Hydraulic Brake Service* and are available from Vocational Media Associates/Prentice-Hall Media, P.O. Box 1050, Mount Kisco, New York 10549-9989.

- *Hydraulic Brake Service: Removing and Replacing Disc Brake Pads.* 1 sound filmstrip.

- *Hydraulic Brake Service: Replacing Seals in a Single-Piston Caliper.* 1 sound filmstrip.

Print Media

- *Brake System Schematic.* Available free from Bendix Automotive Aftermarket, 1094 Bendix Drive, Jackson, Tennessee 38301.

- *Diagnosing Brake Squeal* and *Disc Caliper Repair.* Unbound technical bulletins available free from C.E. Niehoff & Company, Division of TRW, Inc., 4925 Lawrence Avenue, Chicago, Illinois 60630.

- *Disc Brake Caliper Assemblies.* A technical bulletin available free from Autoline, 840 West 31st Street, Chicago, Illinois 60608.

- *Four Piston Disc Brakes* and *Single Piston Disc Brakes.* Manuals available free from AC-Delco, General Motors Corporation, 400 Renaissance Center, Detroit, Michigan 48243.

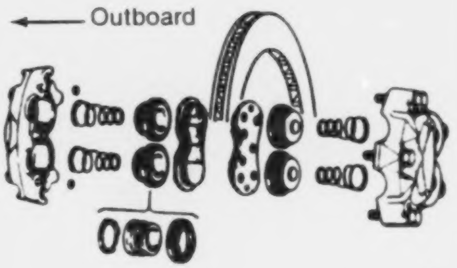
- *Lee Disc Brake Trouble Shooting Guide* and *Lee Disc Brake Assemblies Wall Chart.* Available free from Lee Manufacturing Company, Division of Rolero, Incorporated, 4933 East 154th Street, Cleveland, Ohio 44128.

- *Passenger Car Application/Identification* wall chart. Available free from Thiokol Corporation, Friction Division, P.O. Box 8296, North Enterprise Avenue, Trenton, New Jersey 08650.

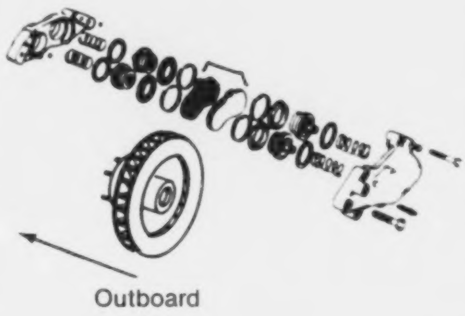
- *Semi-Metallic Pads, Including Gritiron & Metalist Brands and Installation Instructions for Disc Brake Pads.* Available free from the Guardian Corporations, Communication Department, 145 N. Beacon Street, Brighton, Massachusetts 02135.

TYPES OF DISC BRAKE CALIPER ASSEMBLIES

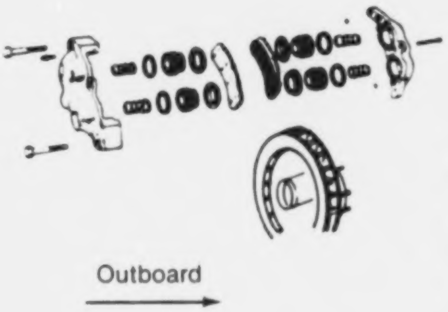
Fixed caliper (Bendix)



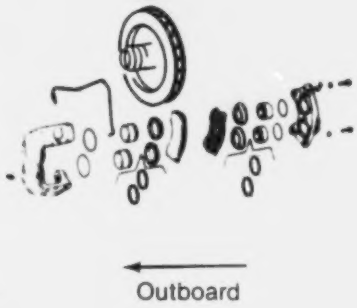
Fixed caliper (Budd)



Fixed caliper (Delco Moraine)

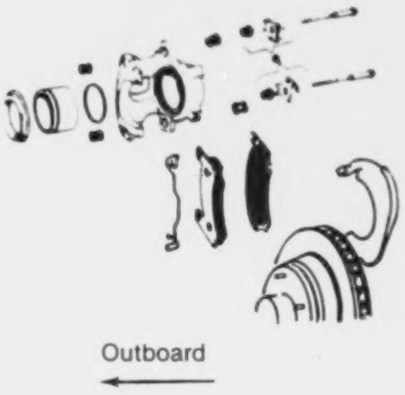


Fixed caliper (Kelsey-Hayes)

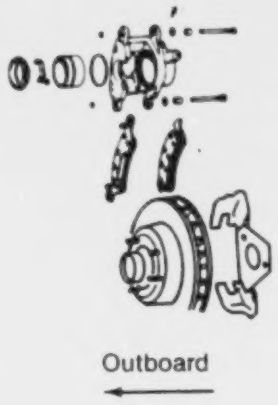


May be photocopied for student use.

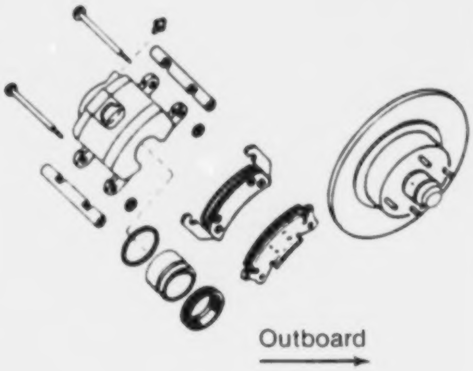
Floating caliper (Kelsey-Hayes)



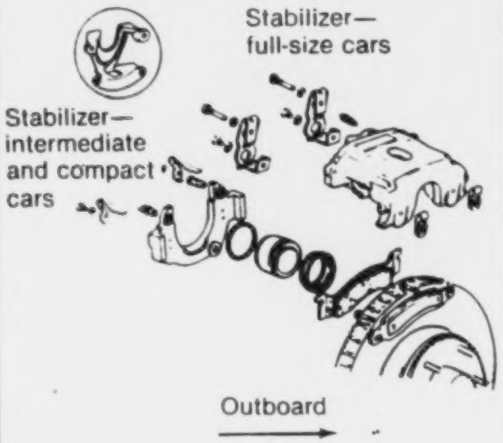
Floating caliper (Delco Moraine)



Floating caliper (Delco Moraine)

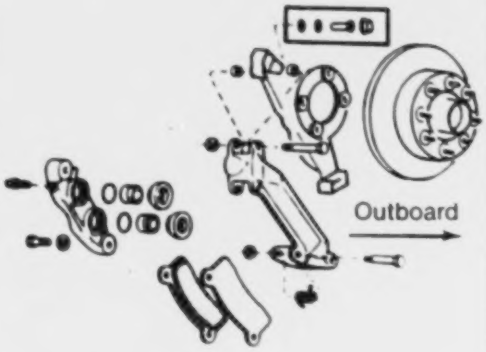


Floating caliper (Kelsey-Hayes)

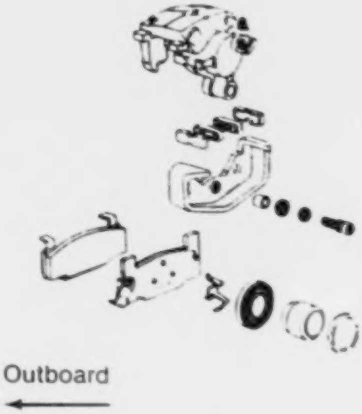

Stabilizer—
full-size cars
Stabilizer—
intermediate
and compact
cars
Outboard

May be photocopied for student use

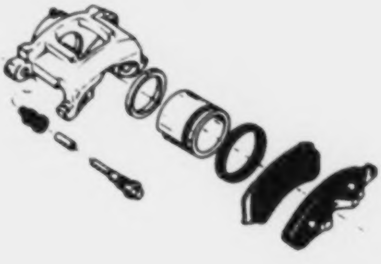
Two-piston floating caliper (Dayton)



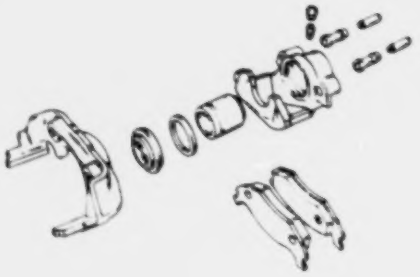
Floating caliper (Delco Moraine)



Floating caliper (Ford)

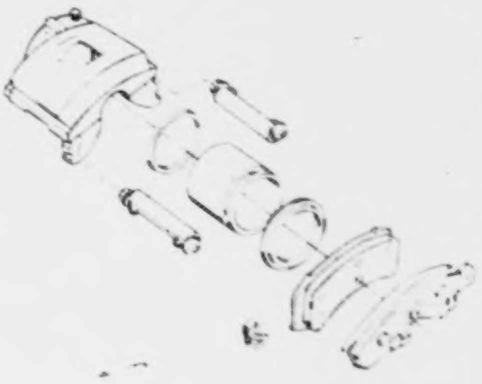


Floating caliper (Kelsey-Hayes)

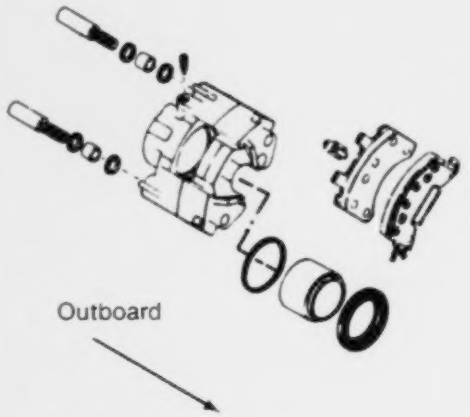


May be photocopied for student use.

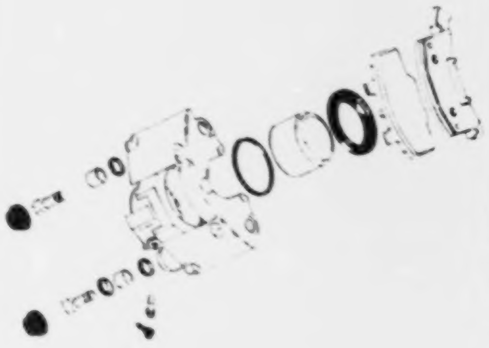
Floating caliper



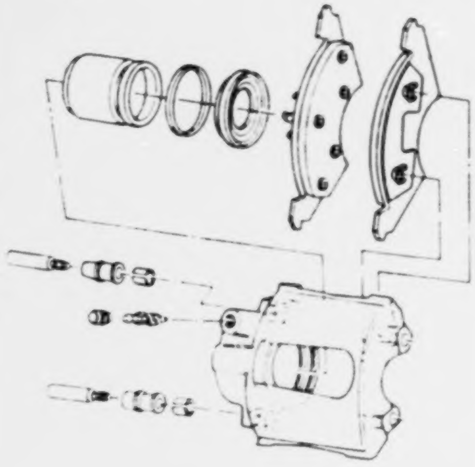
Floating caliper (Delco Moraine)



Floating caliper

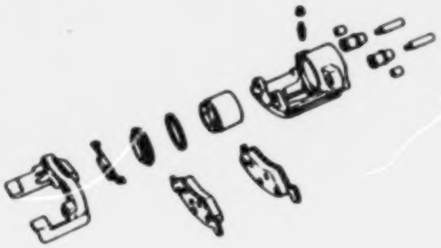


Floating caliper (Delco Moraine)

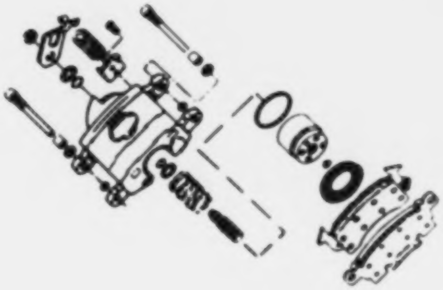


May be photocopied for student use.

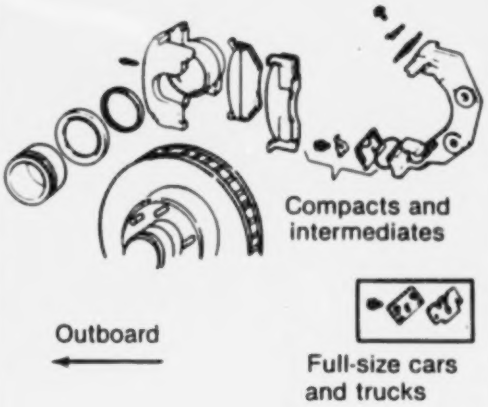
Floating caliper



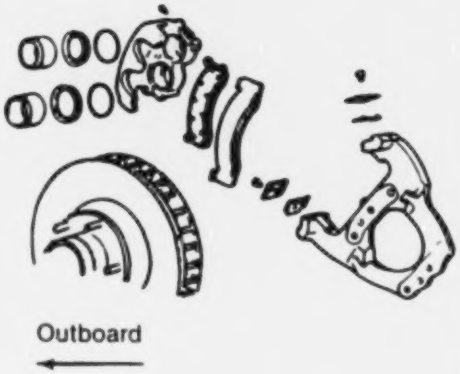
Floating caliper with parking brake (Delco Moraine)



Sliding caliper (Chrysler)

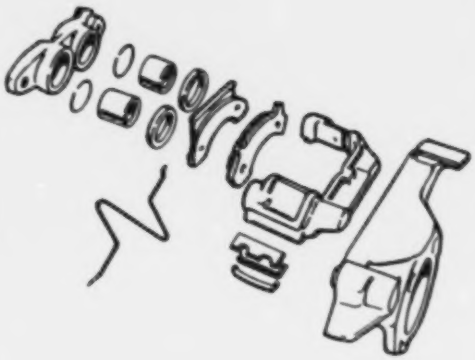

Compacts and intermediates
Outboard
Full-size cars and trucks

Two-piston sliding caliper (Kelsey-Hayes)

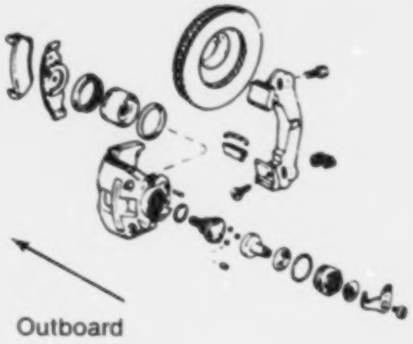


May be photocopied for student use.

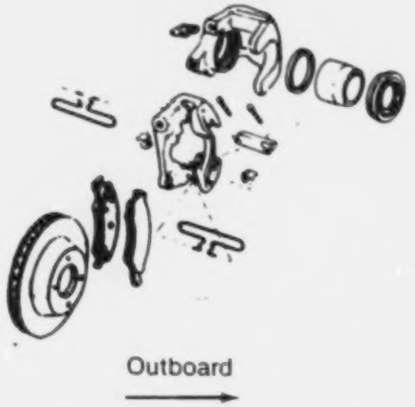
Sliding caliper (Dayton)



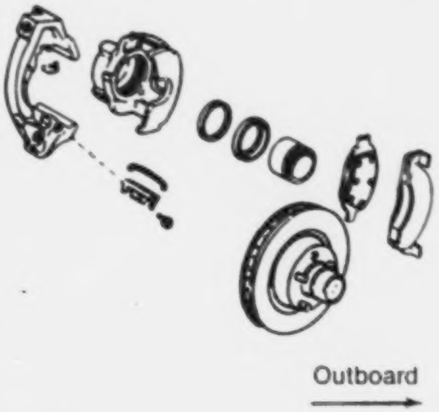
Sliding caliper with parking brake (Kelsey-Hayes)



Sliding caliper (Bendix)



Sliding caliper (Bendix, Kelsey-Hayes)



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BRAKE SYSTEM INSPECTION REPORT FORM

Customer name ______________________________

Address ______________ Telephone number: Work ______________ Home ______________

Vehicle make ______________ Year ______________ Mileage ______________

License number ______________________________

Approximate time required for service ______________________________

Inspected by ______________________________ Date ______________

The condition of the brake system on this vehicle is as follows:

Brake system components	**Required services**	**$ Estimate** **Parts**	 **Labor**
Disc pads	☐ Semi-metallic ☐ Conventional		
Disc caliper	☐ Recondition ☐ Replace		
Disc hardware	☐ Replace		
Disc rotor	☐ Recondition ☐ Replace		
Grease seals	☐ Replace		
Front wheel bearings	☐ Repack ☐ Replace		
Wheel cylinders	☐ Recondition ☐ Replace		
Rear brake hardware	☐ Replace		
Brake shoes	☐ Replace		
Brake drums	☐ Recondition ☐ Replace		
Parking brakes	☐ Adjust ☐ Lubricate ☐ Replace		
Power brake booster	☐ Service ☐ Replace		
Master cylinder	☐ Recondition ☐ Replace		
Brake fluid	☐ Drain old, and add new fluid		
Lines, hoses, combination valve	☐ Replace		
Stop light, warning light	☐ Replace bulb ☐ Replace switch ☐ Adjust ☐ Replace		
Other ______________			
	Total		

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OBJECTIVE 1 **Recognize definitions of terms associated with disc brakes by choosing the correct definitions from lists of three choices.**

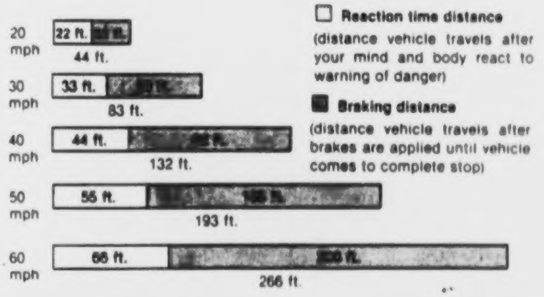
disc brake — brake design in which brake pads contract against a round, flat braking surface to produce braking action

friction — resistance to relative motion between two bodies in contact

FRICTION FOR STOPPING

When brakes are applied on a vehicle, the brake shoes are forced into contact with rotor and/or drum to provide friction that slows the rotation of the wheel. Then, the friction between the tires and the road surface slows the speed of the vehicle. The average stopping distance travelled before the vehicle comes to a full stop is directly related to vehicle speed as shown on the chart below.

Average Stopping Distance



inboard shoe — shoe on vehicle-frame side of brake disc

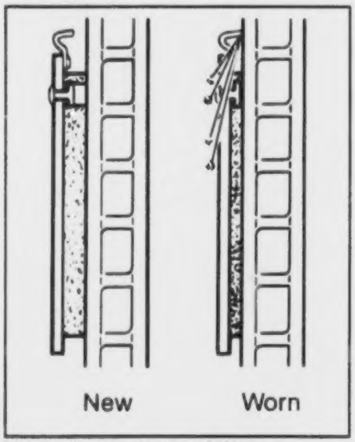
outboard shoe — shoe on wheel-cover side of brake disc

pad wear indicator — thin, metal tab bent so that it contacts rotor and squeals when lining wears to point where it needs to be replaced (Figure 1)

NOTE: Another indicator system uses electrical contacts in the pads that touch the rotor when the pads are worn out. This completes a circuit and turns on a dashboard warning light. This system is found on Chrysler, Ford, and other domestic vehicles, and on imports such as Toyotas and Mercedes-Benz.

EXAMPLE:

FIGURE 1



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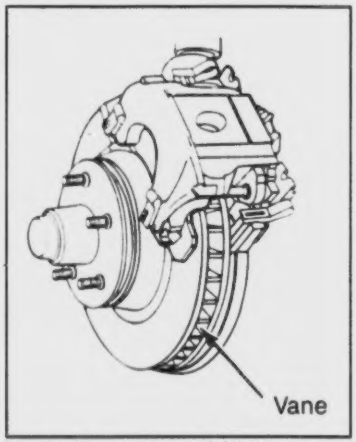
scoring — wear damage from multiple scratches

scuffing — light abrasive damage spread over a large area

vane — thin bridge between the two disc surfaces of a ventilated disc brake rotor (Figure 2)

EXAMPLE:

FIGURE 2



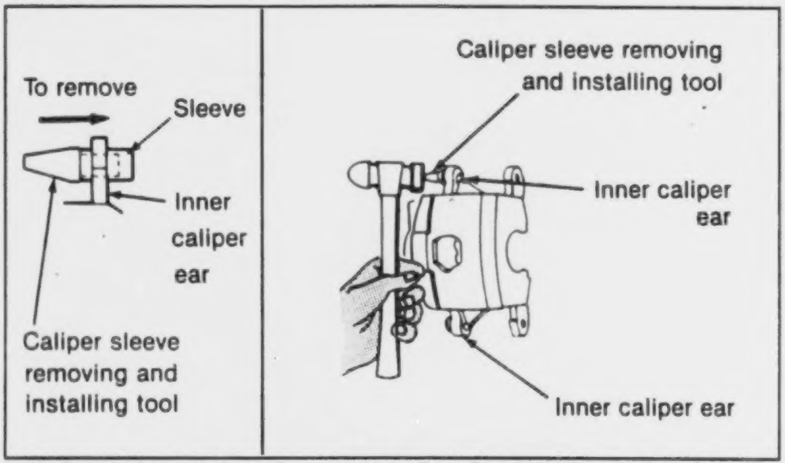
Used with permission of Allied Aftermarket.

OBJECTIVE 2

Recall specialty tools used to service disc brakes by writing the name of the tool when given an illustration.

- **Caliper sleeve removing and installing tool** (Figure 3)

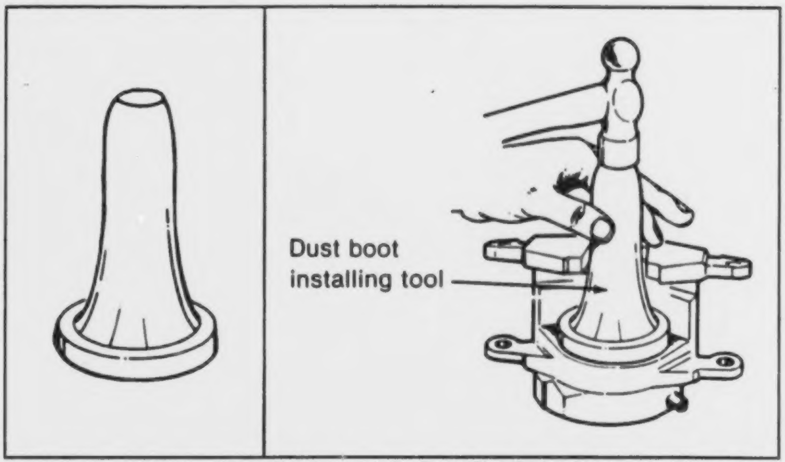
FIGURE 3


To remove
Sleeve
Inner caliper ear
Caliper sleeve removing and installing tool
Caliper sleeve removing and installing tool
Inner caliper ear
Inner caliper ear

(right) From *Automotive Brake Service, Unit 2: Front Disc Brake Service.* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

- **Dust boot installing tool** (Figure 4)

FIGURE 4

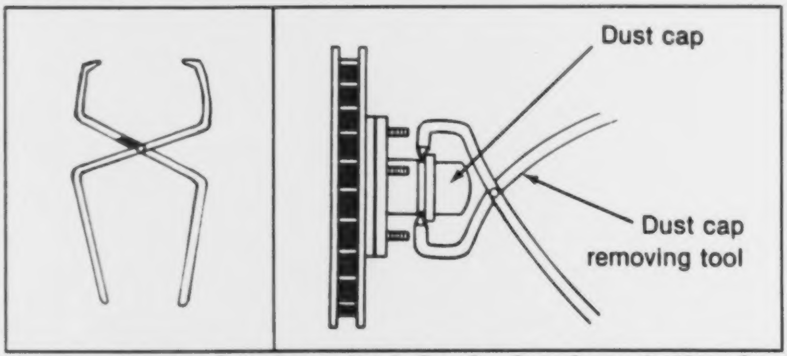

Dust boot installing tool

(right) From *Automotive Brake Service, Unit 2: Front Disc Brake Service.* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

- **Dust cap removing tool** (Figure 5)

  NOTE: The "dust cap" is also called a *grease cap or dust cover.* When a dust cap removing tool is not available, the cap may be removed with channel-lock pliers.

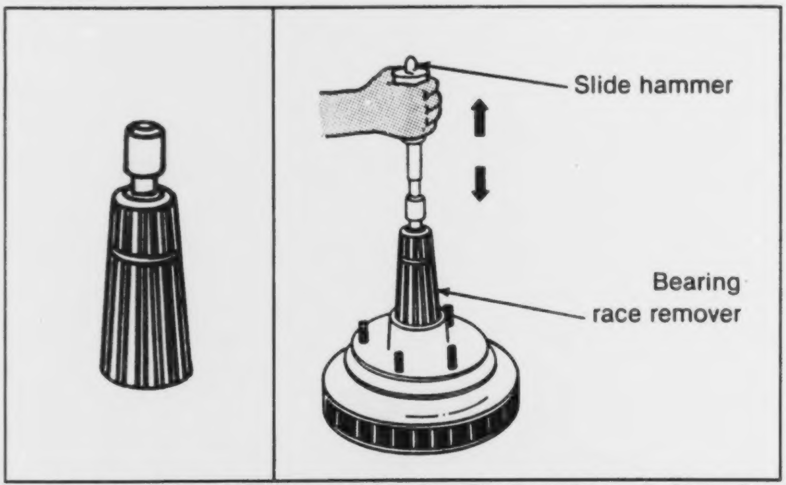
FIGURE 5



(right) From *automotive Brake Service, Unit 2: Front Disc Brake Service,* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

- **Bearing race remover** (Figure 6)

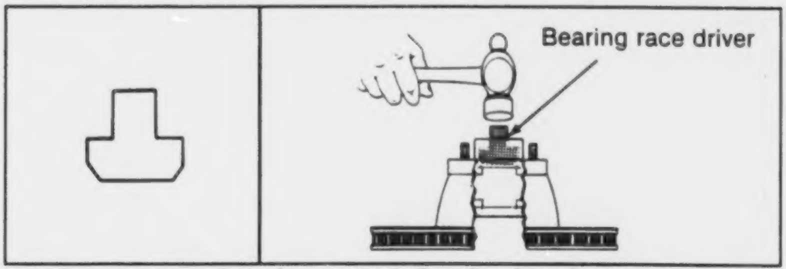
FIGURE 6



(right) From *Automotive Brake Service, Unit 2: Front Disc Brake Service,* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

- **Bearing race driver** (Figure 7)

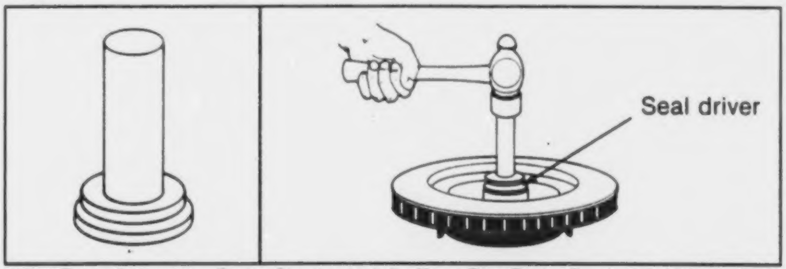
FIGURE 7



(right) From *Automotive Brake Service, Unit 2: Front Disc Brake Service,* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

- **Seal driver** (Figure 8)

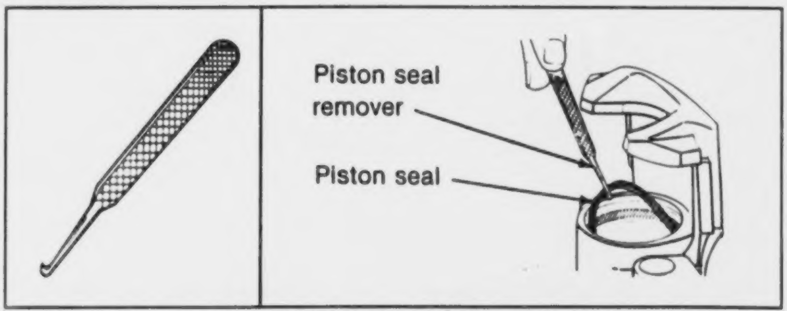
FIGURE 8



(right) From *Automotive Brake Service, Unit 2: Front Disc Brake Service,* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

- **Piston seal remover** (Figure 9)

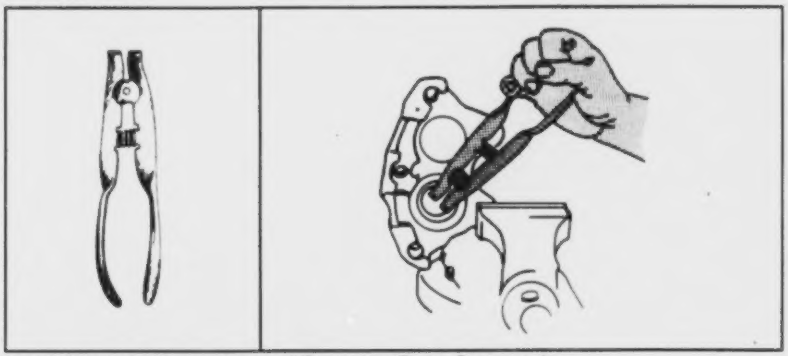
FIGURE 9



(right) From *Automotive Brake Service, Unit 2: Front Disc Brake Service,* © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

- **Piston remover** (Figure 10)

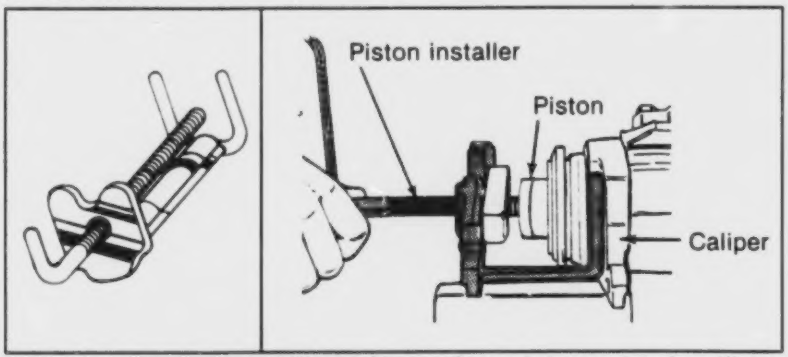
FIGURE 10



(right) Adapted with permission of Raybestos/Brake Systems, Inc.

- **Piston installer** (Figure 11)

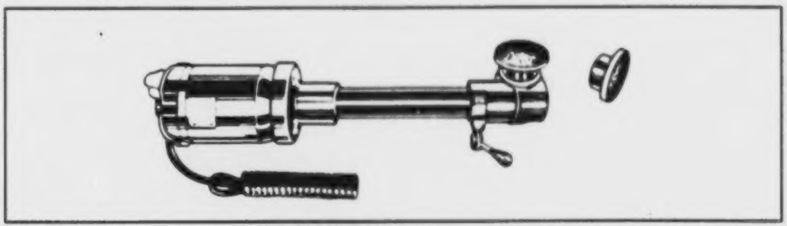
FIGURE 11



(right) Used with permission of Wagner Division, Cooper Industries, Inc., from *Wagner Manual AU-1600*, copyright © 1988

- **Disc rotor grinder** (Figure 12)

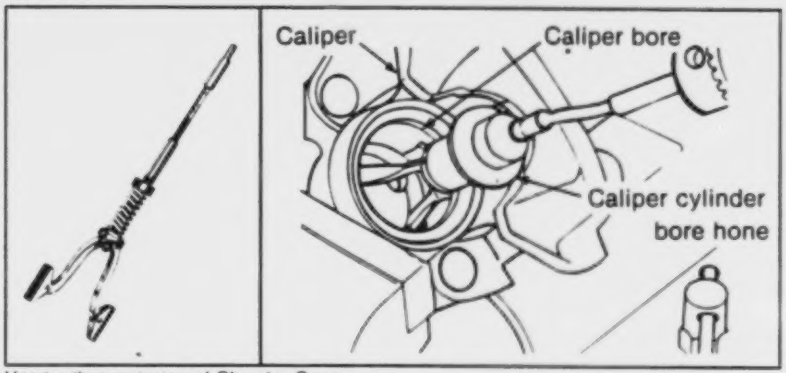
FIGURE 12



Used with permission of AMMCO TOOLS, Inc.

- **Caliper cylinder bore hone** (Figure 13)

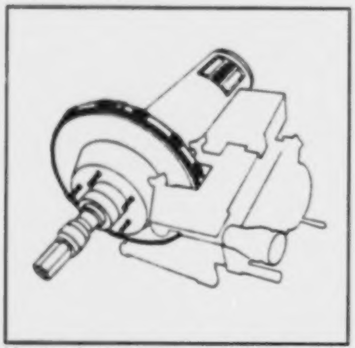
FIGURE 13


Caliper
Caliper bore
Caliper cylinder bore hone

Used with permission of Chrysler Corp.

- **Rotor silencing band for use with ventilated rotor** (Figure 14)

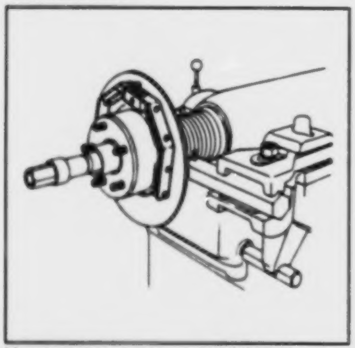
FIGURE 14



Used with permission of AMMCO TOOLS, Inc.

- **Rotor silencer for use when rotor is machined on one side at a time** (Figure 15)

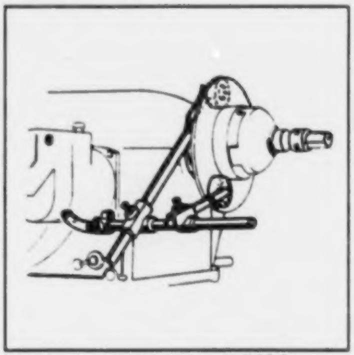
FIGURE 15



Used with permission of AMMCO TOOLS, Inc.

- **Rotor silencer for use on nonventilated rotors** (Figure 16)

FIGURE 16



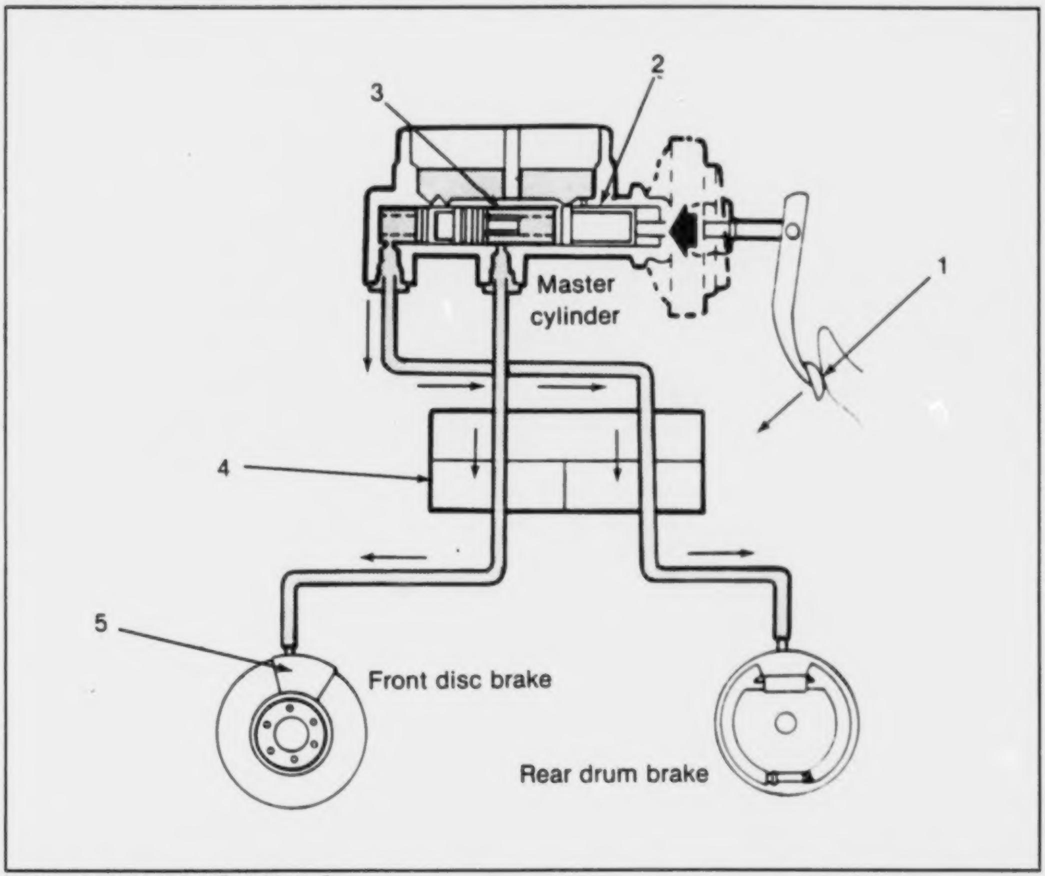
Used with permission of AMMCO TOOLS, Inc.

OBJECTIVE 3

Recall the steps of disc brake operation by listing the steps in order when given a numbered illustration.

1. Brake pedal is depressed.
2. Pushrod forces primary piston in master cylinder forward.
3. Fluid in primary cylinder is pressurized to apply front (disc) brakes.
4. Brake valve is used to delay (meter) front brake application and proportion rear pressure to front pressure on some models.
5. Piston(s) in caliper forces brake shoe against rotor, thus slowing wheel rotation.

FIGURE 17


3
2
1
Master cylinder
4
5
Front disc brake
Rear drum brake

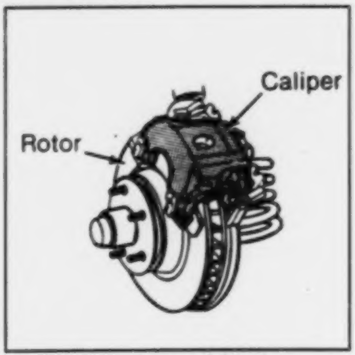
Used with permission of Ford Motor Co.

OBJECTIVE 4 **Recall descriptions of types of disc brake calipers by writing the correct descriptions of each.**

floating caliper — is mounted on bolts through rubber bushings that permit it to move; has one large piston, and the braking force is exerted against caliper adapter (Figure 18)

EXAMPLE:

FIGURE 18

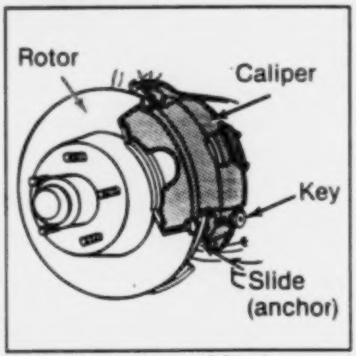


Used with permission of Allied Aftermarket.

sliding caliper — is mounted on machined ways that allow it to move from side to side in caliper adapter, which also receives braking force; has one or two pistons (Figure 19)

EXAMPLE:

FIGURE 19

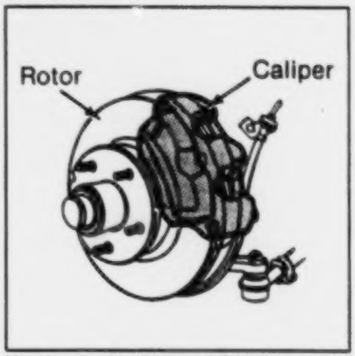


Used with permission of Allied Aftermarket.

fixed caliper — is rigidly bolted directly to steering knuckle; usually has four pistons, two on each side of rotor (Figure 20)

EXAMPLE:

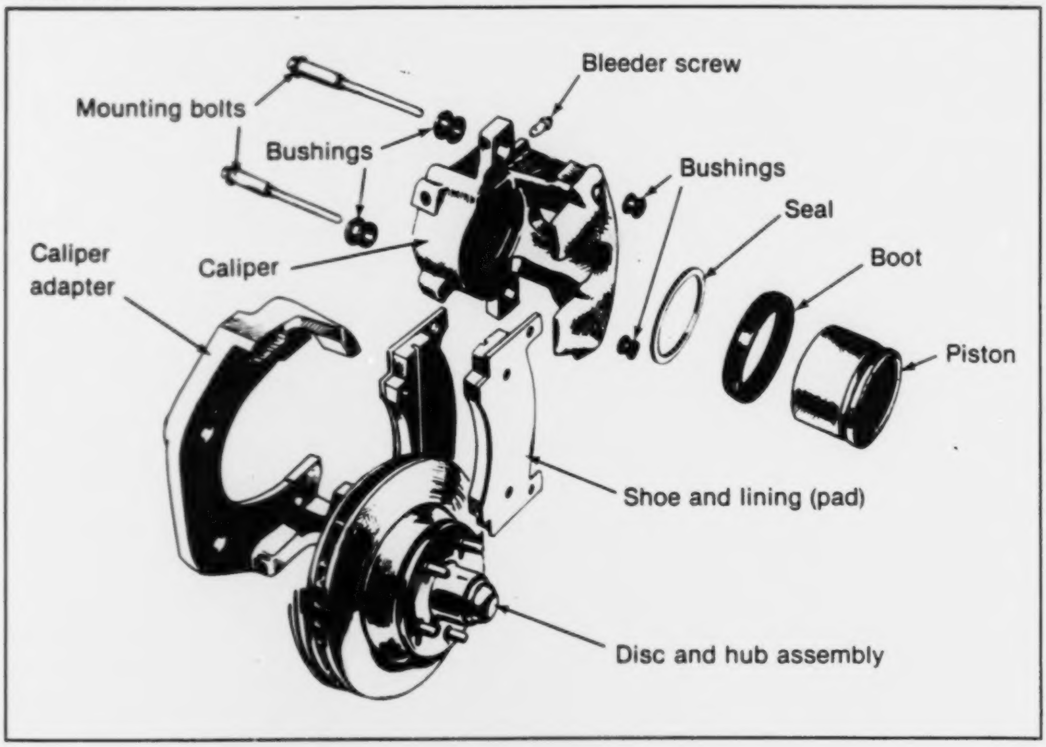
FIGURE 20


Rotor
Caliper

Used with permission of Allied Aftermarket.

OBJECTIVE 5 **Recall the parts of a typical floating caliper assembly by labeling the parts on an illustration.**

FIGURE 21


Bleeder screw
Mounting bolts
Bushings
Bushings
Seal
Caliper adapter
Caliper
Boot
Piston
Shoe and lining (pad)
Disc and hub assembly

GYPSY BRAKE PADS

Brake pads must pass tests set by the Vehicle Equipment Safety Commission, a federally funded commission. One of the tests measures the ability of the brake pad to grip when the brakes are hot. Brake pads made by large, well-known companies have markings stamped into the edges of the friction material of their brake pads, indicating that they have passed this federal standard. Some distributors of off-brand parts sell brake pads that do not meet the standards set by the Vehicle Equipment Safety Commission. These brake pads, called *gypsy brake pads*, do not have these markings in the edges of the friction material.

OBJECTIVE 6

Recall the advantages of disc brake design by writing the advantages.

- Are resistant to heat fade
- Are resistant to water fade
- Provide more straight-line stops
- Adjust automatically and can be equipped with a pad wear indicator
- Are easier to service than drum brakes

DISC BRAKE DESIGN FEATURES

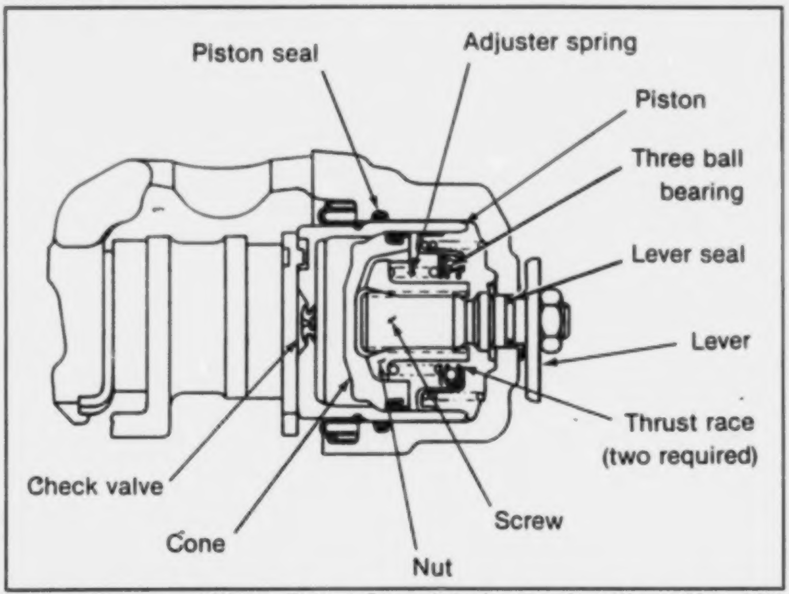
While working with disc brakes, you will realize that the design of disc brakes offers certain advantages. For example, the design of the disc brake rotor exposes more surface to the air than that of drum brakes and thus dissipates heat more efficiently. Also, the rotation of the rotor throws off moisture, thus disc brakes are affected very little by water fade. Disc brakes are less apt to pull than are drum brakes, due to their clamping action, thus producing more straight-line stops. They automatically adjust as pads wear, and some designs are equipped with a device that squeals when the pads need replacement. Disc brakes are of a simpler design than drum brakes, and there are fewer types of designs and fewer movable parts than for drum brakes.

OBJECTIVE 7

Recognize types of parking brakes used on vehicles with rear disc brakes by matching illustration of types of parking brakes to their correct descriptions.

GM Delco-Moraine — mechanically operated lever connected to a high lead screw—which is passed through a nut in the piston—moves piston along screw to engage brake; integral part of regular brake (Figure 22)

FIGURE 22


Piston seal
Adjuster spring
Piston
Three ball bearing
Lever seal
Lever
Thrust race (two required)
Check valve
Cone
Screw
Nut

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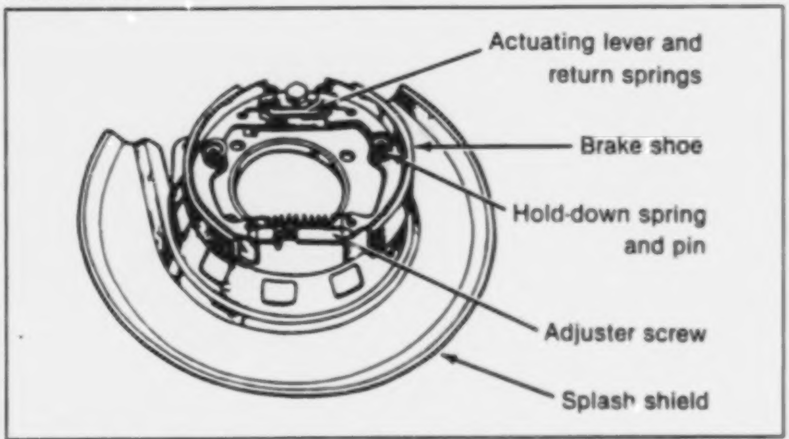
Rear disc/drum (auxiliary drum) — cable-operated parking brake with small 6½-inch diameter servo-type brake with star-wheel adjuster; located within rotor hub, independent of regular brake (Figure 23)

FIGURE 23



Actuating lever and return springs
Brake shoe
Hold-down spring and pin
Adjuster screw
Splash shield

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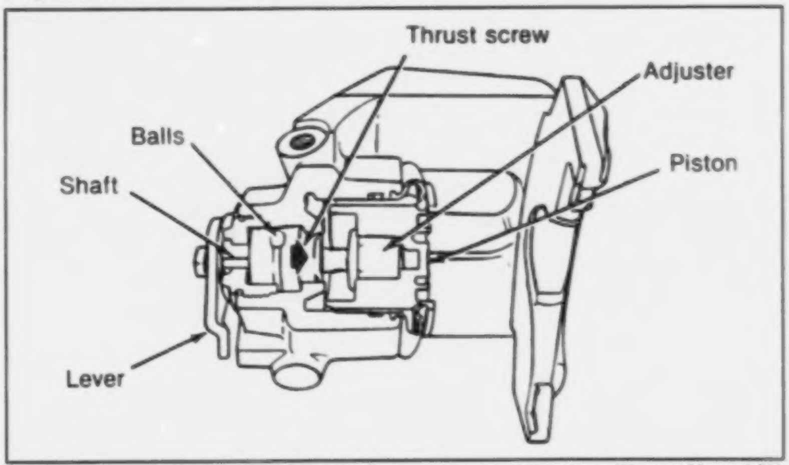
Kelsey-Hayes (Ford) sliding caliper — mechanically operated lever works ball-and-ramp device within parking brake to force pads against rotor; integral part of regular brake (Figure 24)

FIGURE 24



Thrust screw
Adjuster
Balls
Piston
Shaft
Lever

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TROUBLESHOOTING CHART FOR DISC BRAKES

NOTE: This chart covers conditions that may be caused by disc brake problems. However, some of these conditions may result from other malfunctions, such as wheel bearing defects or problems in the suspension or steering systems. This chart is intended to help you diagnose suspected disc brake problems. Other procedures may be required if the problem is elsewhere.

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Depressing brake pedal produces no braking effect	Reservoir fluid level low	Check for cause of fluid leak, repair as required, refill the reservoir
	Air in the hydraulic system	Bleed system
	Bleeder screw open	Close bleeder screw and bleed system
	Improperly positioned pads (while servicing the calipers, pistons may have been pushed back in cylinder bores)	Reposition pads (depress pedal a second time)
	Misadjusted rear brakes	Adjust properly
	Leak in rear brake cylinder	Hone cylinder bore; replace piston seals or replace caliper
	Piston seal damaged in one or more of the cylinders	Disassemble caliper and replace piston seals
	Leak past piston cups in master cylinder	Recondition or replace master cylinder

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Excessive pedal effort	Pads worn below minimum thickness	Install new pads
	Master cylinder or power brake malfunction	Check and correct affected parts
	"Faded" overheated condition, glazed pads, "blued" or heat-checked rotors	Remachine rotor
	Grease, oil, brake fluid on pads	Install new pads
	Seized or frozen pistons	Disassemble caliper and free up pistons
Excessive pedal travel	Air in the system	Bleed system; replenish the fluid
	Insufficient or improper brake fluid (boil)	Drain, flush, and refill with correct fluid
	Master cylinder not functioning properly	Check and repair affected parts
	Excessive rotor runout	Check rotor with dial indicator; install new rotor if runout exceeds maximum specified
	Excessively tapered or warped pads	Install new pads
	Damaged caliper piston seal	Install new piston seal
	Rear brakes out of adjustment	Check and adjust as necessary

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Pedal pulsation (brake roughness or chatter)	Excessive lateral runout of brake rotor	Check rotor with dial indicator; install new rotor if runout exceeds the maximum specified
	Excessive out-of-parallelism of brake rotor	Check parallelism with micrometer, and remachine rotor or install a new one if parallelism exceeds maximum allowed
Car pulls to one side	Brake fluid, oil, grease, water, mud, or dirt on linings	Install new pads
	Unmatched linings	Install matched set of pads
	Seized or frozen pistons	Disassemble caliper and repair
	On rear brakes—misadjustment, sticking pistons or broken spring	Adjust rear brakes, free up the pistons, install new spring
	Distorted disc brake shoes	Install new brake pads
	Restricted hose or line	Examine hoses and lines; replace as necessary
Leaky wheel cylinder	Cylinder bore surface scored or corroded	Disassemble caliper, hone cylinder bore; install new seal
	Caliper piston seal damaged or worn	Disassemble caliper and install new seal

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Front brakes heat up during driving and fail to release	Residual check valve in the master cylinder front brake outlet	Remove that valve from master cylinder at front brake line outlet
	Sticking pedal linkage	Free up and lubricate as necessary
	Frozen or seized pistons	Disassemble caliper and free up pistons
	Driver in habit of riding brake pedal	Instruct driver to give up that habit
Brake noises		
• Chatter	Excessive lateral runout of rotor	Check runout with dial indicator; install new disc if the runout exceeds maximum specified
	Lack of rotor parallelism	Check parallelism with micrometer; remachine disc, or install a new one, as required
• Scraping	Rust or mud buildup on edges of rotor and on caliper housing	Clean or replace as necessary
	Worn pad; metal tabs or backing exposed to rotor	Replace pad; repair or replace faulty parts
• Groan or creep-groan	Releasing brake pedal slower than the spring returns	Slightly increase or decrease pedal effort to eliminate noise
• Rattle	Excessive clearance between shoe and caliper	Install new pads
	Shoe antirattle spring missing or not properly positioned (Kelsey-Hayes or Budd types only)	Install new antirattle spring or position properly

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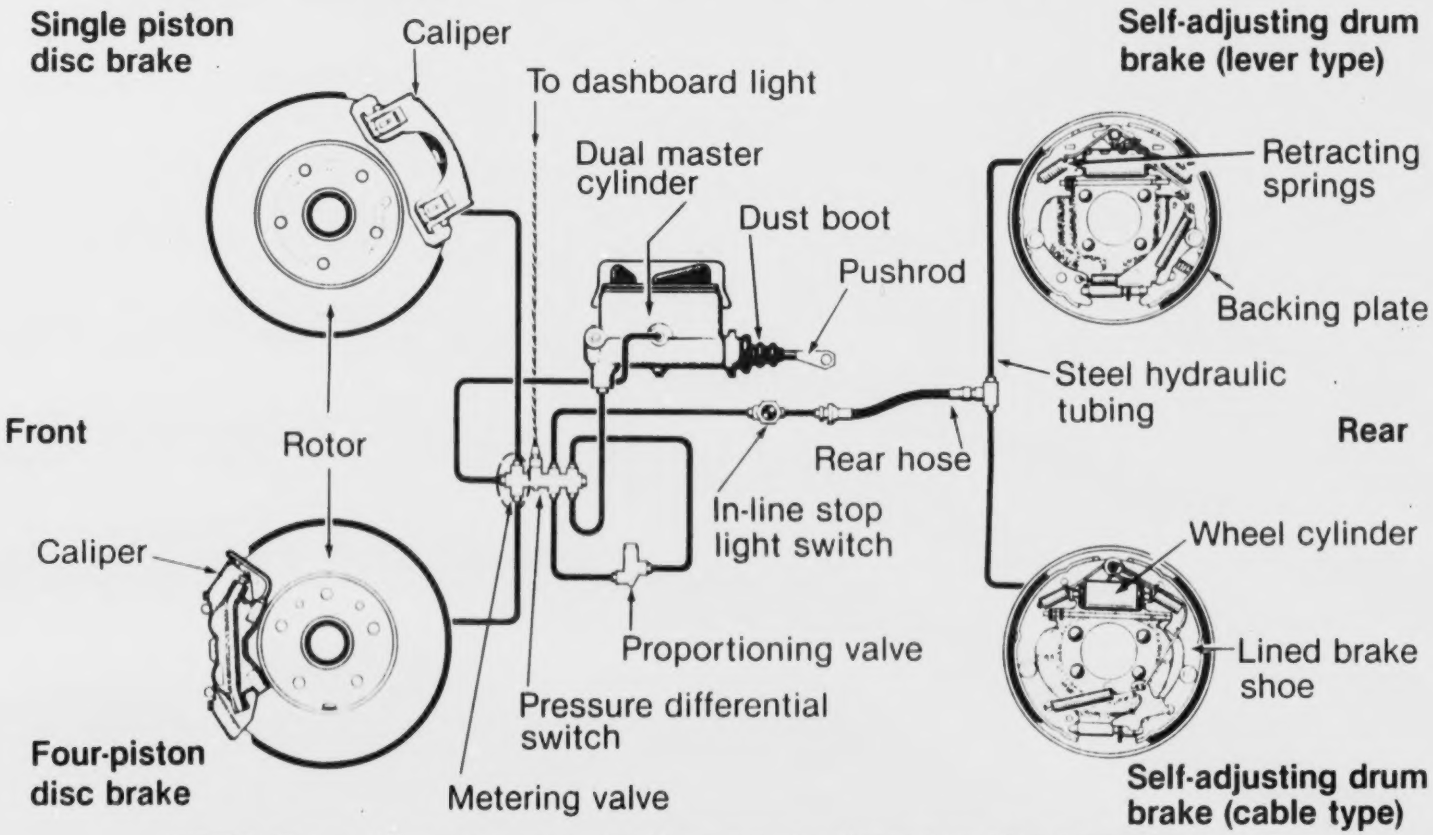
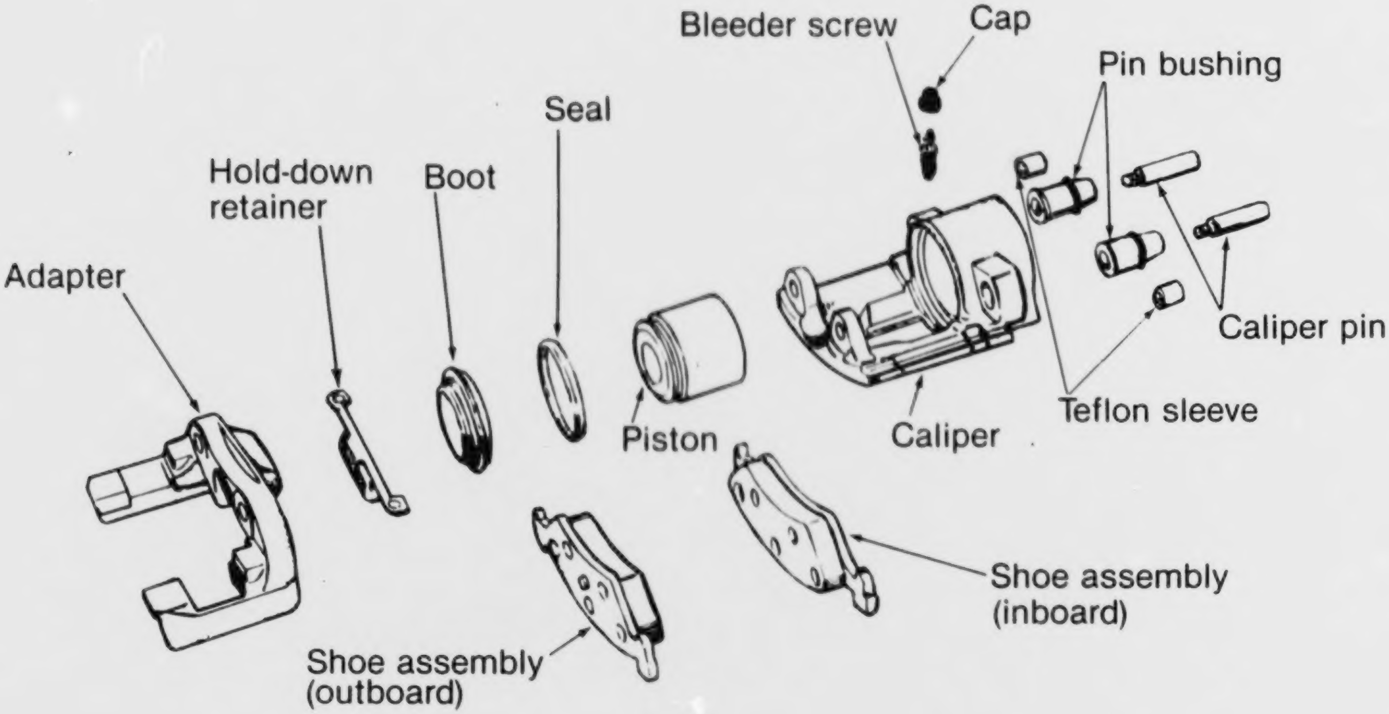
Major Components of a Disc Brake System


Single piston disc brake
Caliper
To dashboard light
Dual master cylinder
Dust boot
Pushrod
Self-adjusting drum brake (lever type)
Retracting springs
Backing plate
Steel hydraulic tubing
Front
Rotor
Rear hose
Rear
In-line stop light switch
Wheel cylinder
Caliper
Proportioning valve
Lined brake shoe
Pressure differential switch
Four-piston disc brake
Metering valve
Self-adjusting drum brake (cable type)

NOTE: Four different brake designs are illustrated in this transparency. In practice, brakes are paired, front or rear.

Used with permission of Raybestos Brake Systems, Inc.

Parts of a Floating Caliper Disc Brake Assembly


Bleeder screw
Cap
Pin bushing
Seal
Hold-down retainer
Boot
Adapter
Caliper pin
Teflon sleeve
Piston
Caliper
Shoe assembly (inboard)
Shoe assembly (outboard)

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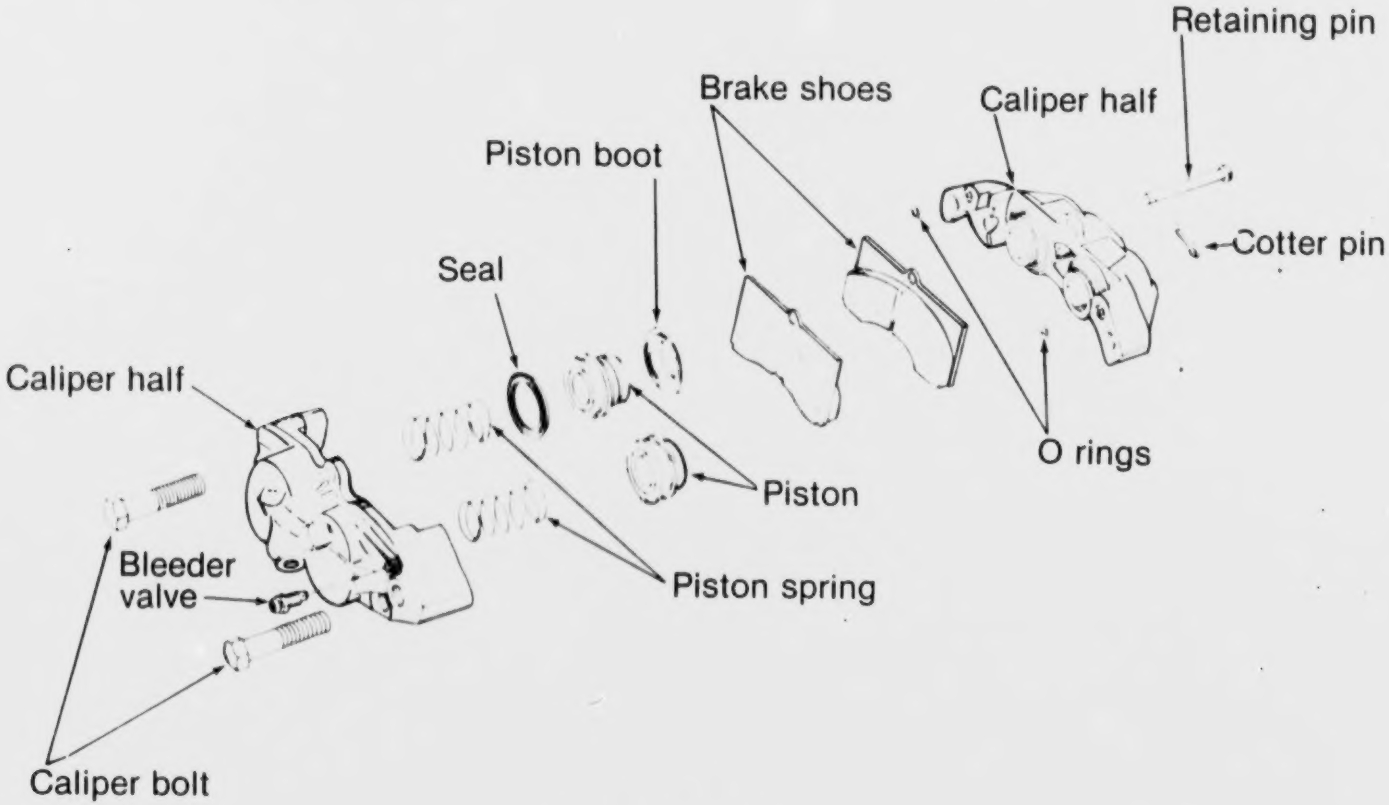
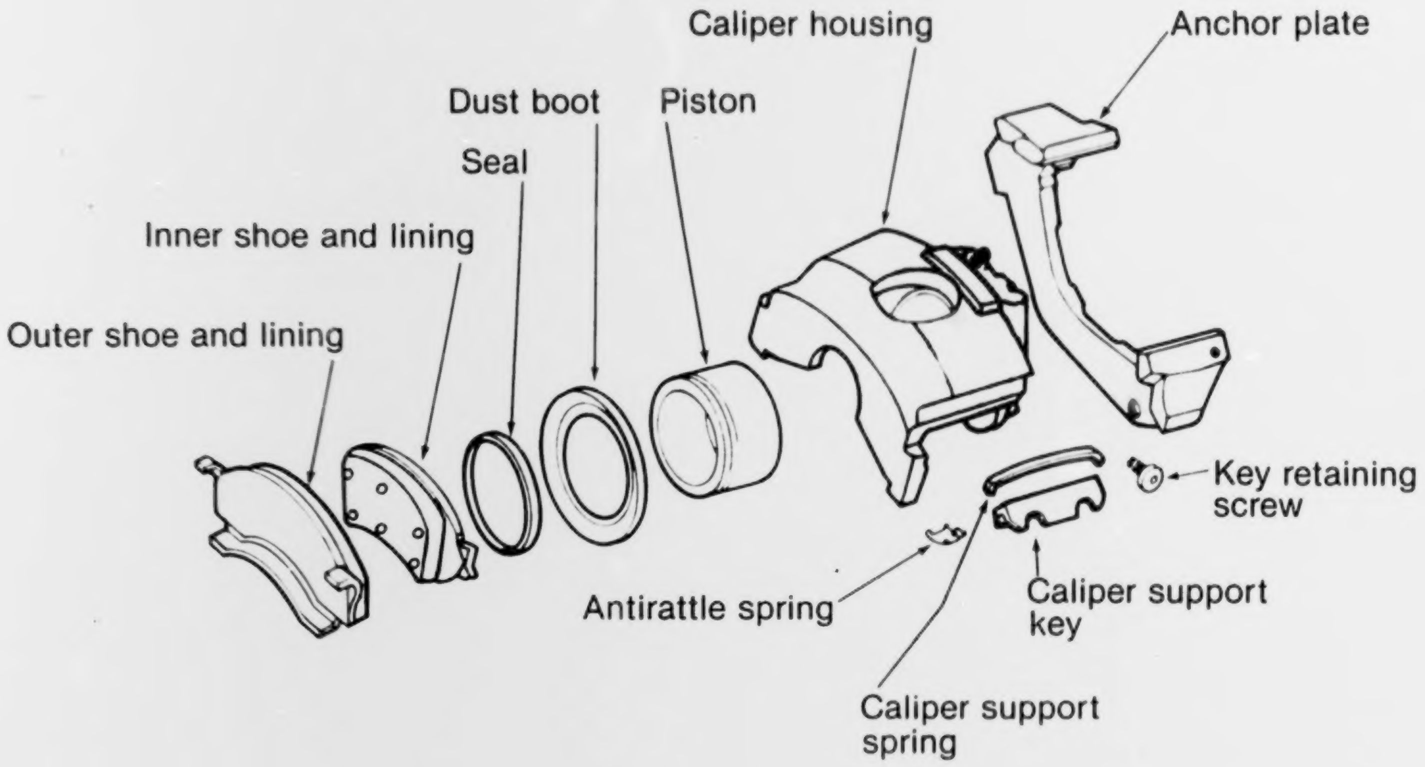
TRANSPARENCY MASTER 3 · Brakes Specialist
CIMC · III · 47

Parts of a Fixed Caliper Disc Brake Assembly


Retaining pin
Brake shoes
Caliper half
Piston boot
Cotter pin
Seal
Caliper half
O rings
Piston
Bleeder valve
Piston spring
Caliper bolt

Used with permission of General Motors Corp

Parts of a Sliding Caliper Disc Brake Assembly


Caliper housing
Anchor plate
Dust boot
Piston
Seal
Inner shoe and lining
Outer shoe and lining
Key retaining screw
Antirattle spring
Caliper support key
Caliper support spring

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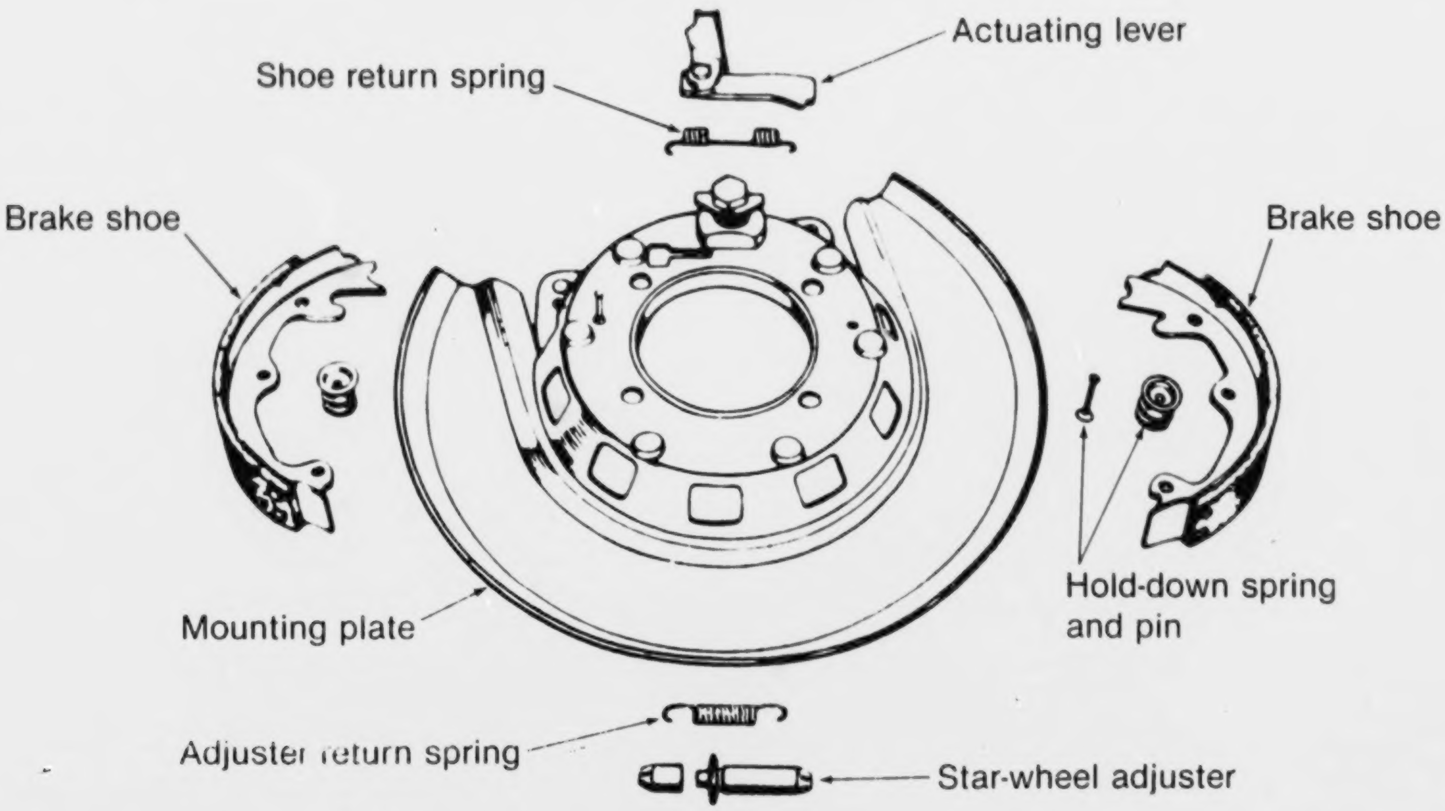
TRANSPARENCY MASTER 5 - Brakes Specialist
CIMC - III - 51

Auxiliary Drum Parking Brake Assembly


Actuating lever
Shoe return spring
Brake shoe
Brake shoe
Hold-down spring and pin
Mounting plate
Adjuster return spring
Star-wheel adjuster

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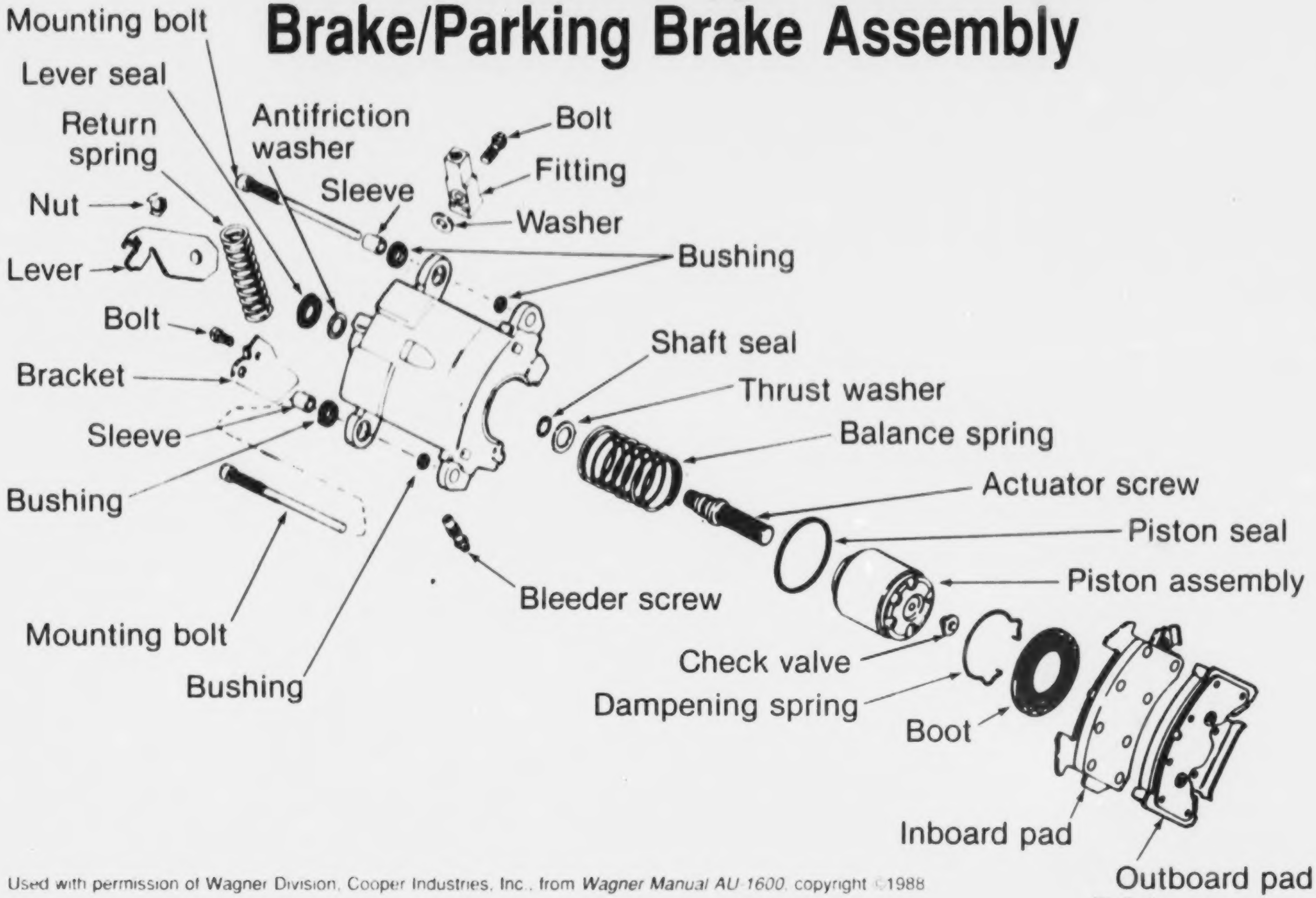
TM 5

TRANSPARENCY MASTER 6 - Brakes Specialist
CIMC - III - 53

Delco-Moraine Type Rear Disc Brake/Parking Brake Assembly


Mounting bolt
Lever seal
Return spring
Antifriction washer
Bolt
Fitting
Sleeve
Washer
Nut
Lever
Bushing
Bolt
Bracket
Shaft seal
Thrust washer
Balance spring
Sleeve
Bushing
Actuator screw
Piston seal
Piston assembly
Bleeder screw
Mounting bolt
Bushing
Check valve
Dampening spring
Boot
Inboard pad
Outboard pad

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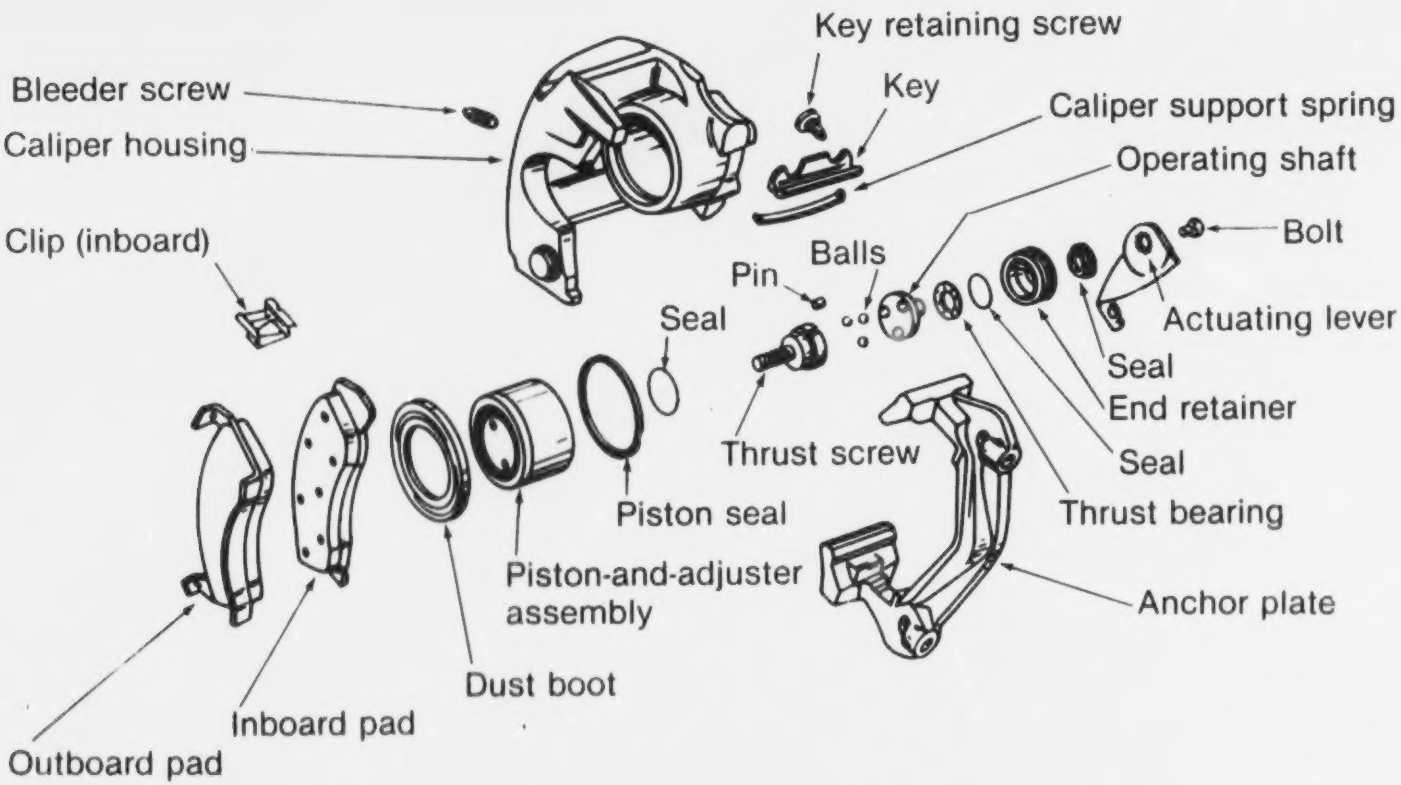
TM 6

Kelsey-Hayes Type Rear Disc Brake/Parking Brake Assembly


Key retaining screw
Bleeder screw
Key
Caliper support spring
Caliper housing
Operating shaft
Bolt
Clip (inboard)
Balls
Pin
Seal
Actuating lever
Seal
End retainer
Thrust screw
Seal
Piston seal
Thrust bearing
Piston-and-adjuster assembly
Anchor plate
Dust boot
Inboard pad
Outboard pad

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ACTIVITY SHEET 1

Development of:
READING SKILLS
INTERPERSONAL OR RELATING SKILLS

- Introduce the assignment to the students by discussing why reading and interpersonal or relating skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING

  - Interpreting graphics & symbols

  INTERPERSONAL OR RELATING

  - Participating in group activities
  - Giving/receiving feedback
- If students have difficulty interpreting graphics and symbols, review the graphics, identifying landmarks and actions taking place.
- If students have difficulty participating in group activities:
  - Discuss the goals of the group.
  - Define each student's responsibilities within the group.
  - Discuss carrying one's fair share of responsibilities.
  - Encourage students to treat each other with courtesy and respect.
  - Explain that everyone's input is important.
  - Stress using active listening skills.
- If students have difficulty giving/receiving feedback:
  - Explain that we learn from our mistakes.

- Remind them to be helpful, courteous, and treat one another with respect.
- Stress using active listening skills.

ACTIVITY SHEET 2

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING

  - Interpreting forms and records

  EMPLOYABILITY

  - Mastering a specific job task/procedure
- If students have difficulty interpreting forms and records:
  - Examine the structure of the forms being used.
  - Review the terminology on the form.
  - Review the purpose of the form.
- If students have difficulty mastering a specific job task/procedure:
  - Emphasize the fact that practice makes a person proficient and proficiency makes a person confident.
  - Suggest they study each component of the procedure to determine which area is causing difficulty.
  - Review the entire procedure.
  - Team them with proficient students or professionals to practice the procedure.

ACTIVITY SHEET 1

SERVICING DISC BRAKES

III

Name ______________________ Score ________

ANSWER GENERAL QUESTIONS ABOUT DISC BRAKES

INTRODUCTION

To become certified as a Brakes Technician, you must pass a test on the brake system compiled by the National Institute for Automotive Service Excellence. The certification test covers all aspects of a vehicle's braking system. This activity sheet covers only disc brakes, but it contains realistic questions similar in content and style to those found on the actual ASE certification test.

DIRECTIONS

Functional Reading Skills
- Interpret graphics and symbols

General Relating Skills
- Participate in group activities

Teamwork/ Cooperative Skills
- Give/receive feedback

Read each of the following study questions twice. The second time you may notice a key word that you overlooked the first time. Every word in the question is important and may provide a clue to the right answer. Select the answer that is **most** correct and write its letter in the answer blank.

_____ 1. The most common type of disc brake caliper found on American cars today is the

a. Single-piston sliding
b. Two-piston fixed
c. Two-piston sliding
d. Four piston fixed

_____ 2. A vehicle being serviced has excessive lateral runout of the brake rotor. Technician A says this may have been caused by incorrect torquing of lug nuts. Technician B says this may be due to a warped rotor. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 3. To check rotor parallelism, you use a

a. Straightedge
b. Micrometer
c. Dial indicator
d. Special service tool

_____ 4. A vehicle equipped with power disc brakes requires excessive pedal effort to stop. Technician A says that the brake pads could be worn below minimum thickness. Technician B says that the pads could be contaminated with grease, oil, or brake fluid. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither A nor B

_____ 5. The owner of a vehicle with front disc brakes states that the brake pedal pulsates rapidly when the brakes are applied. Which of the following could cause such a condition?

a. Reservoir fluid level low
b. Uneven rotor thickness
c. Misadjusted rear brakes
d. All of the above

_____ 6. Which of the following conditions are causes for caliper reconditioning?

a. Frozen pistons
b. Leaks
c. Damaged dust boots
d. All of the above

_____ 7. When checking disc brake rotor lateral runout

a. Use an inside micrometer
b. Use a pair of calipers
c. Use an outside micrometer
d. Use a dial indicator

_____ 8. A technician should determine the minimum allowable rotor thickness by

a. Measuring 1 inch from the rotor edge with a micrometer
b. Checking the specification stamped on the rotor
c. Consulting the vehicle service manual
d. b or c

_____ 9. Before replacing disc brake pads, remove some of the brake fluid from the master cylinder reservoir that feeds the disc brakes. This will

a. Prevent fluid overflow when pistons are pushed back into calipers
b. Make bleeding easier
c. Allow pressure to front and rear axles to equalize
d. Prevent the brake warning light from coming on

_____ 10. The owner of an American passenger car complains of a pull to the right when she steps on the brakes. Technician A says that the trouble could be caused by a sticking pedal linkage. Technician B says that the trouble could be caused by unmatched or contaminated linings. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 11. As a general guildeline when reconditioning disc brake calipers, a technician should

a. Remove both calipers and mark them R (right) and L (left)
b. Clean all parts with alcohol or alcohol-based cleaning fluid
c. Lightly hone cylinder walls to remove black stains
d. Use an assembly lubricant recommended by the service manual

_____ 12. When servicing a rear disc/drum (auxiliary drum) brake, if the wear shims are damaged, the technician should replace

a. The star wheel adjuster
b. The entire mounting plate assembly
c. The adjuster return spring
d. The hold down springs and pins

ACTIVITY SHEET 2

SERVICING DISC BRAKES

III

Name ______________________ Score ________

INTERPRET SERVICE MANUAL DIAGNOSTIC CHARTS

INTRODUCTION

Most service manuals contain brake diagnostic charts that refer the specialist to other tables or charts for specific makes and models of vehicles. These charts are more specific than those found in training manuals and textbooks and provide greater detail than the general textbook-type charts. Often these service manual charts indicate not only the problem and corrective actions needed, but also outline a troubleshooting sequence or procedure.

DIRECTIONS

Study the following service manual charts carefully and then refer to the appropriate chart to answer the questions that follow.

BASIC DIAGNOSIS GUIDE

SYMPTOM	CHART 1 MISC. COND.	CHART 2 ACTUATION	CHART 3 POWER BRAKES	CHART 4 BRAKE NOISE	CHART 5 WHEEL BRAKES
BRAKE WARNING LIGHT "ON"		X	NO		
EXCESSIVE PEDAL TRAVEL		X	NO		0
PEDAL GOES TO FLOOR	60	X			
STOP LIGHT "ON" WITHOUT BRAKES	3X				
ALL BRAKES DRAG	5X	0			
REAR BRAKES DRAG	2X	NO	NO		
GRABBY BRAKES			0		X
SPONGY BRAKE PEDAL		X	NO		
PREMATURE REAR LOCKUP	40	NO	NO		0
EXCESSIVE PEDAL EFFORT	1X		0		
ROUGH ENGINE IDLE			0		
BRAKE CHATTER (ROUGH)		NO	NO		X
SURGE DURING BRAKING					X
NOISE DURING BRAKING				X	
RATTLE OR CLUNKING NOISE		NO		X	
PEDAL PULSATES DURING BRAKING		NO	NO		X
PULL TO RIGHT OR LEFT		NO	NO		X

NO: NOT POSSIBLE CAUSE X: MOST LIKELY CAUSE 0: POSSIBLE CAUSE

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CHART 1 — MISCELLANEOUS CONDITIONS

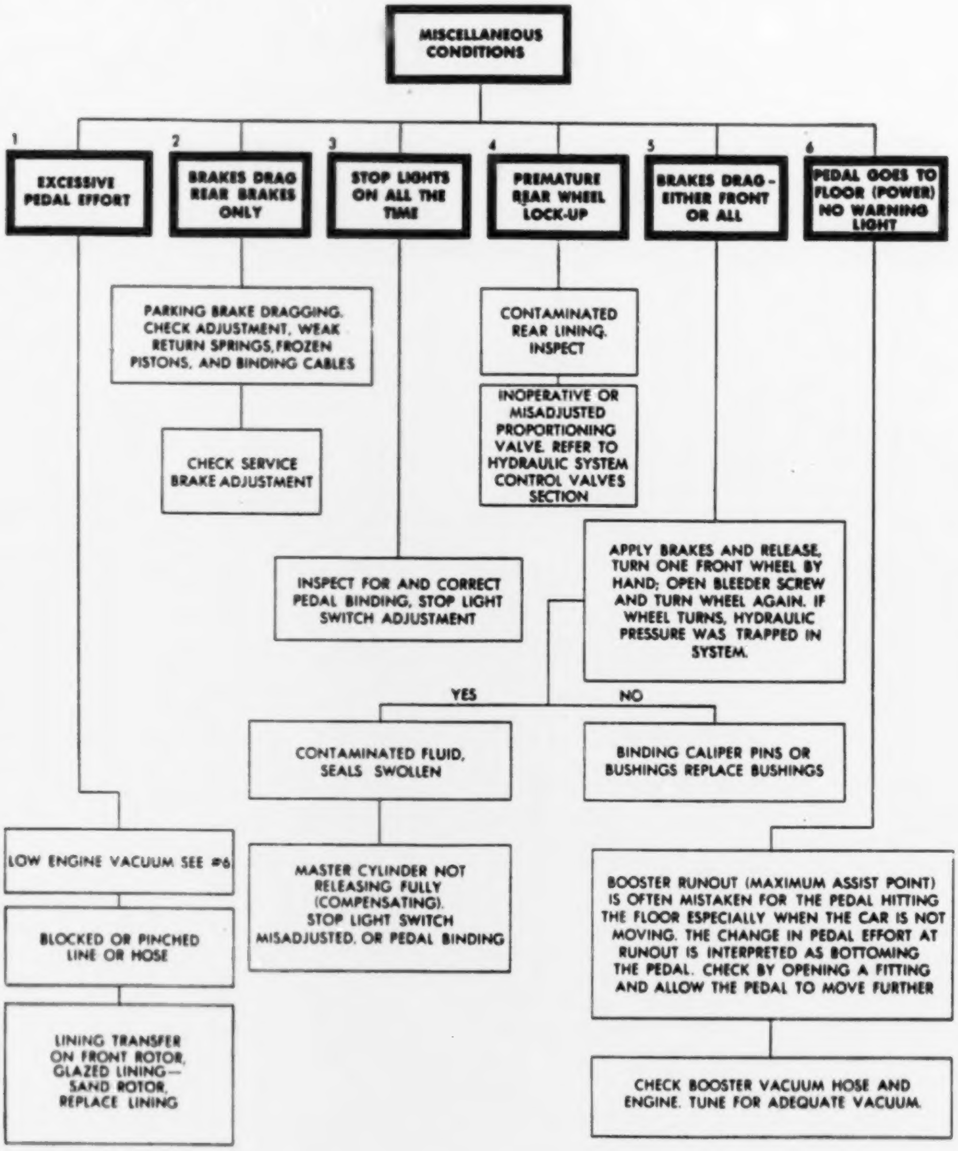

MISCELLANEOUS CONDITIONS
1 EXCESSIVE PEDAL EFFORT
2 BRAKES DRAG REAR BRAKES ONLY
3 STOP LIGHTS ON ALL THE TIME
4 PREMATURE REAR WHEEL LOCK-UP
5 BRAKES DRAG - EITHER FRONT OR ALL
6 PEDAL GOES TO FLOOR (POWER) NO WARNING LIGHT
PARKING BRAKE DRAGGING. CHECK ADJUSTMENT, WEAK RETURN SPRINGS, FROZEN PISTONS, AND BINDING CABLES
CHECK SERVICE BRAKE ADJUSTMENT
CONTAMINATED REAR LINING. INSPECT
INOPERATIVE OR MISADJUSTED PROPORTIONING VALVE. REFER TO HYDRAULIC SYSTEM CONTROL VALVES SECTION
INSPECT FOR AND CORRECT PEDAL BINDING, STOP LIGHT SWITCH ADJUSTMENT
APPLY BRAKES AND RELEASE, TURN ONE FRONT WHEEL BY HAND; OPEN BLEEDER SCREW AND TURN WHEEL AGAIN. IF WHEEL TURNS, HYDRAULIC PRESSURE WAS TRAPPED IN SYSTEM.
YES
NO
CONTAMINATED FLUID, SEALS SWOLLEN
BINDING CALIPER PINS OR BUSHINGS REPLACE BUSHINGS
MASTER CYLINDER NOT RELEASING FULLY (COMPENSATING). STOP LIGHT SWITCH MISADJUSTED, OR PEDAL BINDING
LOW ENGINE VACUUM SEE #6
BLOCKED OR PINCHED LINE OR HOSE
LINING TRANSFER ON FRONT ROTOR, GLAZED LINING—SAND ROTOR, REPLACE LINING
BOOSTER RUNOUT (MAXIMUM ASSIST POINT) IS OFTEN MISTAKEN FOR THE PEDAL HITTING THE FLOOR ESPECIALLY WHEN THE CAR IS NOT MOVING. THE CHANGE IN PEDAL EFFORT AT RUNOUT IS INTERPRETED AS BOTTOMING THE PEDAL. CHECK BY OPENING A FITTING AND ALLOW THE PEDAL TO MOVE FURTHER
CHECK BOOSTER VACUUM HOSE AND ENGINE. TUNE FOR ADEQUATE VACUUM.

CHART 2—ACTUATION

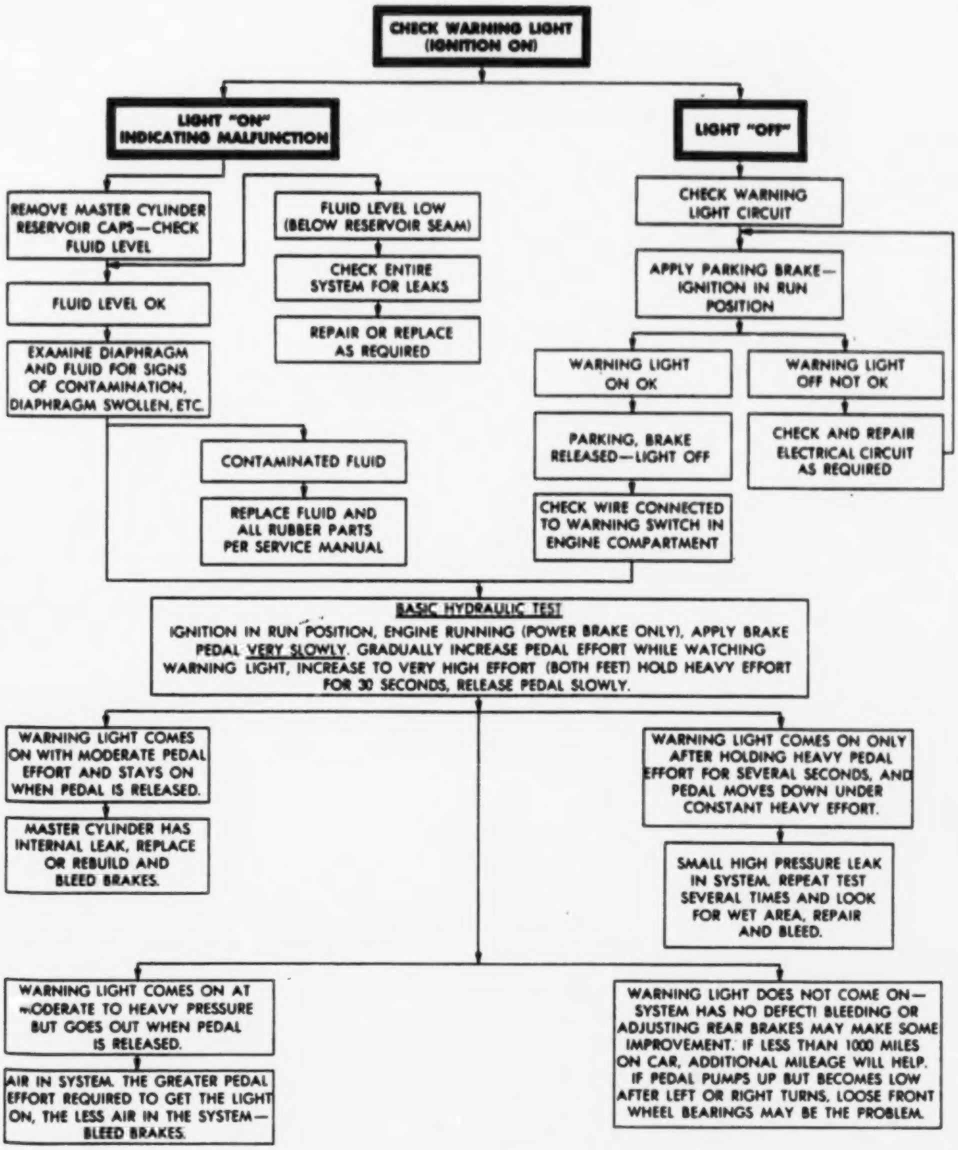

CHECK WARNING LIGHT (IGNITION ON)
LIGHT "ON" INDICATING MALFUNCTION
LIGHT "OFF"
REMOVE MASTER CYLINDER RESERVOIR CAPS—CHECK FLUID LEVEL
FLUID LEVEL LOW (BELOW RESERVOIR SEAM)
CHECK ENTIRE SYSTEM FOR LEAKS
REPAIR OR REPLACE AS REQUIRED
FLUID LEVEL OK
EXAMINE DIAPHRAGM AND FLUID FOR SIGNS OF CONTAMINATION, DIAPHRAGM SWOLLEN, ETC.
CONTAMINATED FLUID
REPLACE FLUID AND ALL RUBBER PARTS PER SERVICE MANUAL
CHECK WARNING LIGHT CIRCUIT
APPLY PARKING BRAKE—IGNITION IN RUN POSITION
WARNING LIGHT ON OK
WARNING LIGHT OFF NOT OK
PARKING, BRAKE RELEASED—LIGHT OFF
CHECK AND REPAIR ELECTRICAL CIRCUIT AS REQUIRED
CHECK WIRE CONNECTED TO WARNING SWITCH IN ENGINE COMPARTMENT
BASIC HYDRAULIC TEST
IGNITION IN RUN POSITION, ENGINE RUNNING (POWER BRAKE ONLY), APPLY BRAKE PEDAL VERY SLOWLY. GRADUALLY INCREASE PEDAL EFFORT WHILE WATCHING WARNING LIGHT, INCREASE TO VERY HIGH EFFORT (BOTH FEET) HOLD HEAVY EFFORT FOR 30 SECONDS, RELEASE PEDAL SLOWLY.
WARNING LIGHT COMES ON WITH MODERATE PEDAL EFFORT AND STAYS ON WHEN PEDAL IS RELEASED.
MASTER CYLINDER HAS INTERNAL LEAK, REPLACE OR REBUILD AND BLEED BRAKES.
WARNING LIGHT COMES ON ONLY AFTER HOLDING HEAVY PEDAL EFFORT FOR SEVERAL SECONDS, AND PEDAL MOVES DOWN UNDER CONSTANT HEAVY EFFORT.
SMALL HIGH PRESSURE LEAK IN SYSTEM. REPEAT TEST SEVERAL TIMES AND LOOK FOR WET AREA, REPAIR AND BLEED.
WARNING LIGHT COMES ON AT MODERATE TO HEAVY PRESSURE BUT GOES OUT WHEN PEDAL IS RELEASED.
AIR IN SYSTEM. THE GREATER PEDAL EFFORT REQUIRED TO GET THE LIGHT ON, THE LESS AIR IN THE SYSTEM—BLEED BRAKES.
WARNING LIGHT DOES NOT COME ON—SYSTEM HAS NO DEFECT! BLEEDING OR ADJUSTING REAR BRAKES MAY MAKE SOME IMPROVEMENT. IF LESS THAN 1000 MILES ON CAR, ADDITIONAL MILEAGE WILL HELP. IF PEDAL PUMPS UP BUT BECOMES LOW AFTER LEFT OR RIGHT TURNS, LOOSE FRONT WHEEL BEARINGS MAY BE THE PROBLEM.

CHART 3—POWER BRAKES

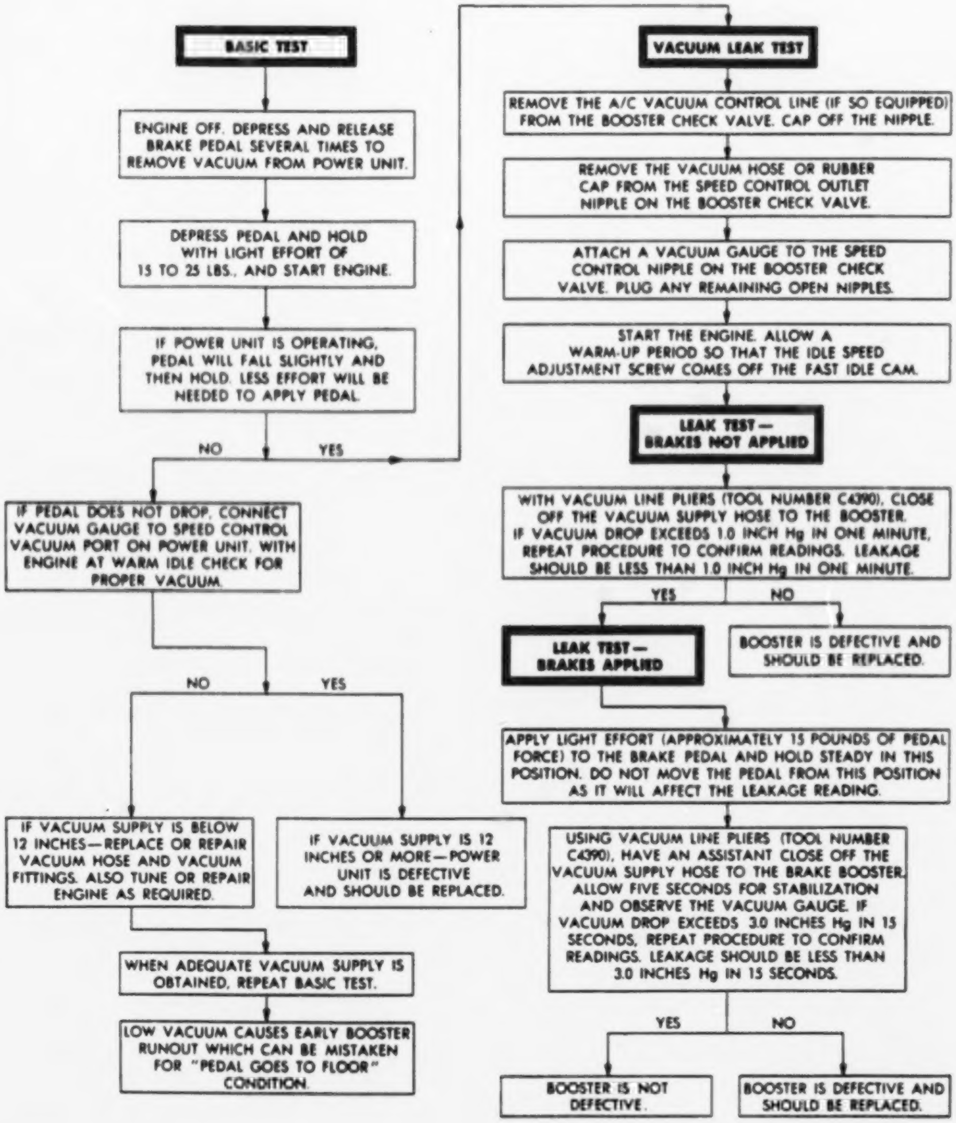
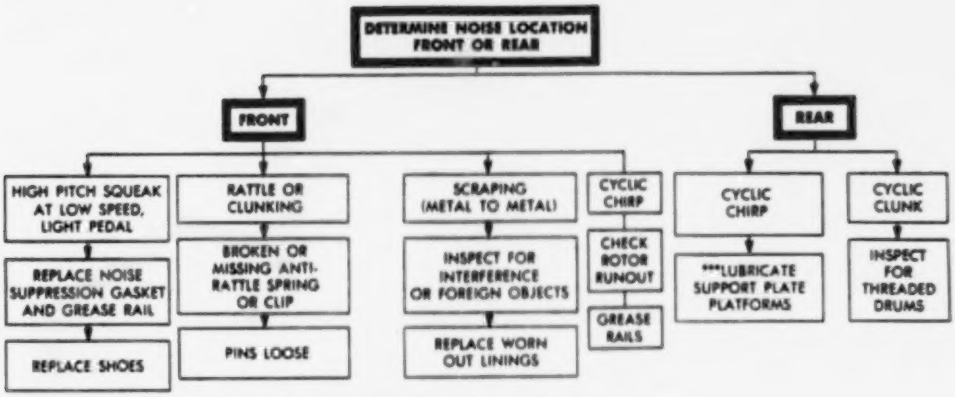
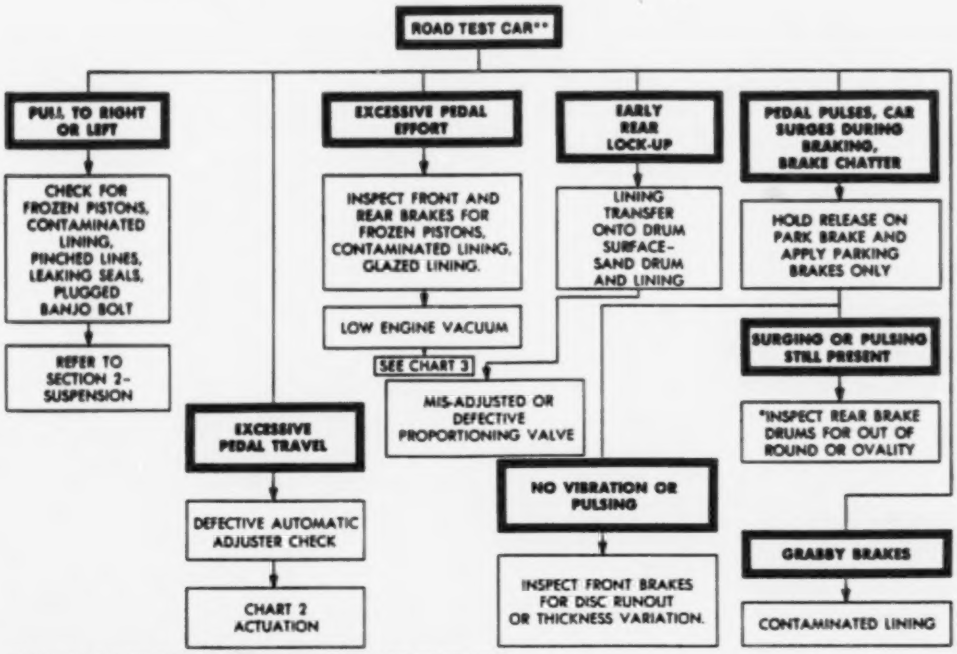

BASIC TEST
ENGINE OFF. DEPRESS AND RELEASE BRAKE PEDAL SEVERAL TIMES TO REMOVE VACUUM FROM POWER UNIT.
DEPRESS PEDAL AND HOLD WITH LIGHT EFFORT OF 15 TO 25 LBS., AND START ENGINE.
IF POWER UNIT IS OPERATING, PEDAL WILL FALL SLIGHTLY AND THEN HOLD. LESS EFFORT WILL BE NEEDED TO APPLY PEDAL.
NO
YES
IF PEDAL DOES NOT DROP, CONNECT VACUUM GAUGE TO SPEED CONTROL VACUUM PORT ON POWER UNIT. WITH ENGINE AT WARM IDLE CHECK FOR PROPER VACUUM.
NO
YES
IF VACUUM SUPPLY IS BELOW 12 INCHES—REPLACE OR REPAIR VACUUM HOSE AND VACUUM FITTINGS. ALSO TUNE OR REPAIR ENGINE AS REQUIRED.
IF VACUUM SUPPLY IS 12 INCHES OR MORE—POWER UNIT IS DEFECTIVE AND SHOULD BE REPLACED.
WHEN ADEQUATE VACUUM SUPPLY IS OBTAINED, REPEAT BASIC TEST.
LOW VACUUM CAUSES EARLY BOOSTER RUNOUT WHICH CAN BE MISTAKEN FOR "PEDAL GOES TO FLOOR" CONDITION.
VACUUM LEAK TEST
REMOVE THE A/C VACUUM CONTROL LINE (IF SO EQUIPPED) FROM THE BOOSTER CHECK VALVE. CAP OFF THE NIPPLE.
REMOVE THE VACUUM HOSE OR RUBBER CAP FROM THE SPEED CONTROL OUTLET NIPPLE ON THE BOOSTER CHECK VALVE.
ATTACH A VACUUM GAUGE TO THE SPEED CONTROL NIPPLE ON THE BOOSTER CHECK VALVE. PLUG ANY REMAINING OPEN NIPPLES.
START THE ENGINE. ALLOW A WARM-UP PERIOD SO THAT THE IDLE SPEED ADJUSTMENT SCREW COMES OFF THE FAST IDLE CAM.
LEAK TEST—BRAKES NOT APPLIED
WITH VACUUM LINE PLIERS (TOOL NUMBER C4390), CLOSE OFF THE VACUUM SUPPLY HOSE TO THE BOOSTER. IF VACUUM DROP EXCEEDS 1.0 INCH Hg IN ONE MINUTE, REPEAT PROCEDURE TO CONFIRM READINGS. LEAKAGE SHOULD BE LESS THAN 1.0 INCH Hg IN ONE MINUTE.
YES
NO
LEAK TEST—BRAKES APPLIED
BOOSTER IS DEFECTIVE AND SHOULD BE REPLACED.
APPLY LIGHT EFFORT (APPROXIMATELY 15 POUNDS OF PEDAL FORCE) TO THE BRAKE PEDAL AND HOLD STEADY IN THIS POSITION. DO NOT MOVE THE PEDAL FROM THIS POSITION AS IT WILL AFFECT THE LEAKAGE READING.
USING VACUUM LINE PLIERS (TOOL NUMBER C4390), HAVE AN ASSISTANT CLOSE OFF THE VACUUM SUPPLY HOSE TO THE BRAKE BOOSTER. ALLOW FIVE SECONDS FOR STABILIZATION AND OBSERVE THE VACUUM GAUGE. IF VACUUM DROP EXCEEDS 3.0 INCHES Hg IN 15 SECONDS, REPEAT PROCEDURE TO CONFIRM READINGS. LEAKAGE SHOULD BE LESS THAN 3.0 INCHES Hg IN 15 SECONDS.
YES
NO
BOOSTER IS NOT DEFECTIVE.
BOOSTER IS DEFECTIVE AND SHOULD BE REPLACED.

CHART 4—BRAKE NOISE


DETERMINE NOISE LOCATION FRONT OR REAR
FRONT
REAR
HIGH PITCH SQUEAK AT LOW SPEED, LIGHT PEDAL
REPLACE NOISE SUPPRESSION GASKET AND GREASE RAIL
REPLACE SHOES
RATTLE OR CLUNKING
BROKEN OR MISSING ANTI-RATTLE SPRING OR CLIP
PINS LOOSE
SCRAPING (METAL TO METAL)
INSPECT FOR INTERFERENCE OR FOREIGN OBJECTS
REPLACE WORN OUT LININGS
CYCLIC CHIRP
CHECK ROTOR RUNOUT
GREASE RAILS
CYCLIC CHIRP
***LUBRICATE SUPPORT PLATE PLATFORMS
CYCLIC CLUNK
INSPECT FOR THREADED DRUMS

***MOPAR MULTIPURPOSE LIUBRICANT, PART NUMBER 4318062, OR EQUIVALENT.

CHART 5—WHEEL BRAKES


ROAD TEST CAR**
PULL TO RIGHT OR LEFT
CHECK FOR FROZEN PISTONS, CONTAMINATED LINING, PINCHED LINES, LEAKING SEALS, PLUGGED BANJO BOLT
REFER TO SECTION 2-SUSPENSION
EXCESSIVE PEDAL TRAVEL
DEFECTIVE AUTOMATIC ADJUSTER CHECK
CHART 2 ACTUATION
EXCESSIVE PEDAL EFFORT
INSPECT FRONT AND REAR BRAKES FOR FROZEN PISTONS, CONTAMINATED LINING, GLAZED LINING.
LOW ENGINE VACUUM
SEE CHART 3
MIS-ADJUSTED OR DEFECTIVE PROPORTIONING VALVE
EARLY REAR LOCK-UP
LINING TRANSFER ONTO DRUM SURFACE-SAND DRUM AND LINING
NO VIBRATION OR PULSING
INSPECT FRONT BRAKES FOR DISC RUNOUT OR THICKNESS VARIATION.
PEDAL PULSES, CAR SURGES DURING BRAKING, BRAKE CHATTER
HOLD RELEASE ON PARK BRAKE AND APPLY PARKING BRAKES ONLY
SURGING OR PULSING STILL PRESENT
*INSPECT REAR BRAKE DRUMS FOR OUT OF ROUND OR OVALITY
GRABBY BRAKES
CONTAMINATED LINING

*PULSATION CAUSED BY REAR BRAKES MAY BE ELIMINATED OR REDUCED BY INDEXING DRUM (REAR) TWO STUDS ON AXLE FLANGE.

**WARNING: Before test driving any car, first check the fluid level in master cylinder, depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low speed stops to be sure that the brakes are safe for road testing.

Functional Reading Skills
- Interpret forms and records

Job Acquisition/ Development Skills
- Master specific job task/ procedure

1. According to the Chrysler Basic Diagnosis Guide, the **most likely** cause of excessive pedal travel can be found on which chart?

____

2. Under which Chart 1 heading would the specialist find the troubleshooting procedure and corrective actions for dragging front brakes?

____

3. Which chart would aid the specialist in determining the cause and corrective procedure for a brake pedal that pulsates during braking?

____

4. The brake warning light is on, indicating a malfunction. You find that the master cylinder fluid is at the correct level, but the master cylinder diaphragm shows signs of contaminated fluid. What corrective action should you take?

____

____

5. You are performing a vacuum leak test without applying the brakes. What is the maximum allowable amount of leakage?

____

6. What might be the cause of a rattle at the front of the vehicle if you determine that it is not caused by a broken or missing antirattle spring or clip?

____

7. The pedal on the vehicle you are servicing pulsates. When you hold the release on the parking brake and apply the parking brakes only, no vibrating or pulsing occurs. What corrective action should you take?

____

____

8. The customer has complained of a repeated chirping sound in the front of the vehicle. What chart would you use to aid in your diagnosis, and what corrective actions would you take?

____

____

____

9. What might be the causes of premature wheel lockup?

____

____

____

10. According to Chart 1, in what section of the service manual would the specialist find the corrective measures to take for an inoperative proportioning valve?

____

11. What should the specialist check for if the vehicle pulls to the right or left?

____

____

____

12. What is the first thing that the specialist should do if the brake warning light will not come on?

____

____

____

13. What condition might binding caliper pins or bushings cause?

____

____

____

ACTIVITY SHEET ANSWERS

SERVICING DISC BRAKES

III

ACTIVITY SHEET 1

1. a
2. c
3. b
4. c
5. b
6. d
7. d
8. d
9. a
10. b
11. d
12. b

ACTIVITY SHEET 2

1. Chart 2—Actuation
2. Chart 1—Miscellaneous Condition, Chart 2—Actuation
3. Chart 5—Wheel Brakes
4. Replace fluid and all rubber parts per service manual.
5. Leakage should be less than 1.0 inch Hg in one minute.
6. Loose pins
7. Inspect front brakes for disc runout or thickness variation .
8. Chart 4—Brake noise; check rotor runout and grease rails
9. Contaminated rear lining or lining transfer onto drum surface; misadjusted, defective, or inoperative proportioning valve
10. "Hydraulic System Control Valves" section
11. Frozen pistons, contaminated linings, pinched lines, leaking seals, plugged banjo bolt
12. Check warning light circuit.
13. Front or all brakes drag.

ASSIGNMENT SHEET

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  — Using in-book references

  EMPLOYABILITY

  — Mastering a specific job task/procedure

- If students have difficulty using in-book reference tools:

  — Show students various in-book reference tools, including tables of contents, charts, illustrations, supplements, and unit objective statements. Identify the content of each and have students identify how each can be used for easy access to text information.

  — Encourage students to use bookmarks or other devices to mark most-used in-book references.

  — Explain to students that books are "random access" tools, meaning the information in them is accessible in any order. Compare books to items which are not random access such as cassette tapes or video films.

  — Have students create their own in-book references by keeping word lists, glossaries, time lines, or lecture notes and relating each piece of information to its textbook location.

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 2.

ASSIGNMENT SHEET

SERVICING DISC BRAKES

III

Name ______________________________ Score ________

OBJECTIVE 8

Diagnose disc brake problems.

INTRODUCTION

Brake service is one of the most important and most common services performed in the automotive industry. State vehicle inspections are now required in most states, and an important part of that inspection is brake inspection. Therefore, vehicle owners need to have their vehicles' brakes periodically checked and repaired so their vehicles comply with state inspection standards. The normal wear and tear of everyday driving takes its toll on the vehicle's braking system. This means that the Brakes Specialist must be able to analyze customer complaints, inspect vehicle brake systems to locate problems, and ultimately diagnose the problems and repair them properly the first time.

DIRECTIONS

Research and Reference Skills
- Use in-book reference tools

Job Acquisition/ Development Skills
- Master specific job task/ procedure

Study the Supplement, Troubleshooting Chart for Disc Brakes, and then read each of the following questions carefully. Select the answer for each that is **most** correct. Write the correct letters in the blanks.

_____ 1. Which of the following would **not** be a reason for installing new brake pads?

a. Excessive clearance between shoe and caliper
b. Improperly positioned pads
c. Oil-contaminated pads

_____ 2. The owner of a late-model vehicle complains of excessive pedal effort. Which of the following is a possible cause?

a. Excessive lateral runout of brake disc
b. Distorted disc brake shoes
c. Pads worn below minimum thickness

_____ 3. You have just reconditioned disc brake calipers and are now testing brake function. When you depress the brake pedal, there is no braking effect. Which of the following is a possible cause?

   a. Brake fluid, oil, grease, water, mud, or dirt on linings
   b. Not enough clearance between shoe and caliper
   c. Improperly positioned pads caused by pistons being pushed back in cylinder boxes

_____ 4. The owner of a vehicle complains that sometimes the brake pedal fails to release. You road test the vehicle to verify the complaint and discover that the problem is caused by the front brakes heating up during driving. Which of the following would be a possible cause of this problem?

   a. Sticking pedal linkage
   b. Reservoir fluid level low
   c. Damaged caliper piston seal

_____ 5. You have just determined that the reason a customer's vehicle pulls to one side is that the pistons are seized or frozen. Which of the following would be the proper corrective measure?

   a. Disassemble caliper and repair
   b. Bleed caliper
   c. Drill ¼-inch hole in piston to free up

_____ 6. Following up on a customer complaint, you find that the brake pads are worn and the metal tabs are exposed to the rotor. Which of the following was the customer's complaint?

   a. Chatter-type noise
   b. Scraping sound
   c. Deep groan

_____ 7. In servicing a vehicle, you determine that the cause of brake pedal pulsation is excessive out-of-parallelism of the brake rotor. Which of the following would be the proper corrective measure?

a. Check rotor diameter with micrometer and install new rotor if variation exceeds maximum allowed
b. Check rotor thickness with dial indicator and install new rotor if variation exceeds maximum allowed
c. Check rotor thickness with micrometer and remachine rotor or install new rotor if variation exceeds maximum allowed

_____ 8. In following up on a customer complaint, you find that the bleeder screw is open. Which of the following was the customer's complaint?

a. No braking effect when brake pedal is depressed
b. Excessive pedal travel
c. Excessive pedal effort

_____ 9. The owner of a late-model Toronado equipped with a Kelsey-Hayes type caliper complains of hearing a rattling sound in the front of the vehicle. Which of the following would be a possible cause?

a. Rust or mud buildup on edges of rotor and on caliper housing
b. Faulty caliper alignment permitting rotor to touch housing
c. Shoe antirattle spring missing or not properly positioned

_____10. A driver in the habit of riding the brake pedal may cause which of the following conditions?

a. Excessive pedal travel
b. Front brakes heat up during driving and fail to release
c. Pedal pulsation (brake roughness or chatter)

ASSIGNMENT ANSWERS

SERVICING DISC BRAKES

III

ASSIGNMENT SHEET

1. b
2. c
3. c
4. a
5. a
6. b
7. c
8. a
9. c
10. b

JOB SHEET 1

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  — Using standard references

  — Interpreting graphics & symbols

  EMPLOYABILITY

  — Mastering a specific job task/procedure

- If students have difficulty using standard references:

  — Locate and explain the purpose of the reference section of the library.

  — Discuss the fact that each standard reference provides a specific type of information.

  — Review each element of the service manual that might be used, including exploded illustrations, rotated illustrations, parts lists, allowable variance charts, and procedure instructions. Discuss the use for and importance of each element.

  — Review the use of other references, including computer data bases and telephone help lines.

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1.

JOB SHEET 2

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  — Using standard references

  — Interpreting graphics & symbols

  EMPLOYABILITY

  — Mastering a specific job task/procedure

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheets 1 & 2 and Job Sheet 1.

JOB SHEET 3

Development of:
READING SKILLS
WRITING SKILLS
MATHEMATICS SKILLS
SCIENCE SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, writing, mathematics, science, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  — Using standard references

  — Following written instructions

  — Interpreting graphics & symbols

WRITING

- — Completing forms and records

MATHEMATICS

- — Performing metric calculations
- — Using English & metric measures
- — Making measurements

SCIENCE

- — Using scientific instruments (dial indicator, micrometer)

EMPLOYABILITY

- — Mastering a specific job task/procedure
- — Practicing good work habits/attitudes

- If students have difficulty completing forms and records:
  - — Examine the structure of the forms being used.
  - — Stress the importance of accurate, legible records.
  - — Review the purpose of the form.
- If students have difficulty performing metric calculations:
  - — Link the work to metric calculations the students are familiar with, such as calculating money or percentages.
  - — Have students identify units of measurement as they complete the calculations.
- If students have difficulty using English and metric measures or making measurements:
  - — Review the units of measure in the English and metric systems.
  - — Determine which system is needed for this procedure.

  - Demonstrate the correct way to measure using the specific measuring instrument.

- If students have difficulty using a scientific instrument (dial indicator, micrometer), review the correct procedure for its use.

- If students have difficulty practicing good work habits/attitudes:

  - Encourage them to become familiar with the entire procedure before they begin the work.

  - Discuss the role that good work habits and attitudes have in obtaining and retaining employment.

  - Discuss what behaviors and attitudes constitute good work habits.

  - Make sure the student knows what is expected of him or her.

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 2 and Job Sheets 1 & 2.

JOB SHEET 4

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  - Using standard references

  EMPLOYABILITY

  - Mastering a specific job task/procedure

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 2 and Job Sheet 1.

JOB SHEET 5

Development of:
READING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  - Using standard references
  - Following written instructions
  - Interpreting graphics & symbols

  EMPLOYABILITY

  - Mastering a specific job task/procedure
  - Practicing good work habits/attitudes

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 2, and Job Sheets 1 & 2.

JOB SHEETS 6 & 7

Development of:
READING SKILLS
SCIENCE SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, science, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  - Using standard references
  - Following written instructions
  - Interpreting graphics & symbols

SCIENCE

— Using scientific instruments (torque wrench)

EMPLOYABILITY

— Mastering a specific job task/procedure

— Practicing good work habits/attitudes

- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 2 and Job Sheets 1-3.

JOB SHEET 1

SERVICING DISC BRAKES

III

OBJECTIVE 9

Remove, clean, inspect, and reinstall caliper assembly and brake pads.

INTRODUCTION

Essentially, the front disc brake assembly operates in the following manner. A clamping device, or caliper, is mounted around a rotating disc, or rotor, to which the wheel is attached. The clamping action of the caliper presses a pair of shoe pads against the sides of the rotor. The resulting friction slows the rotor, which in turn slows the wheel.

The shoe pads are activated by one or more pistons forced out of bores in the caliper by hydraulic pressure. The caliper may have one, two, or four pistons, depending on the design, although most vehicles have single piston calipers. Single piston calipers are usually called *sliding calipers*.

Sliding or floating calipers usually must be lifted off the rotor for pad replacement. Fixed calipers may have pads that can be replaced by removing retaining pins or clips instead of having to lift off the entire caliper.

Because there is such a wide variety of caliper designs, service procedures vary considerably. Because of this, proper removal and installation procedures can be found only in the manufacturer's service manual. Certain precautions and guidelines, however, must be considered when removing, cleaning, inspecting, and reinstalling front disc brake calipers and shoe pads. These guidelines and precautions are listed below and on the following pages.

General guidelines:

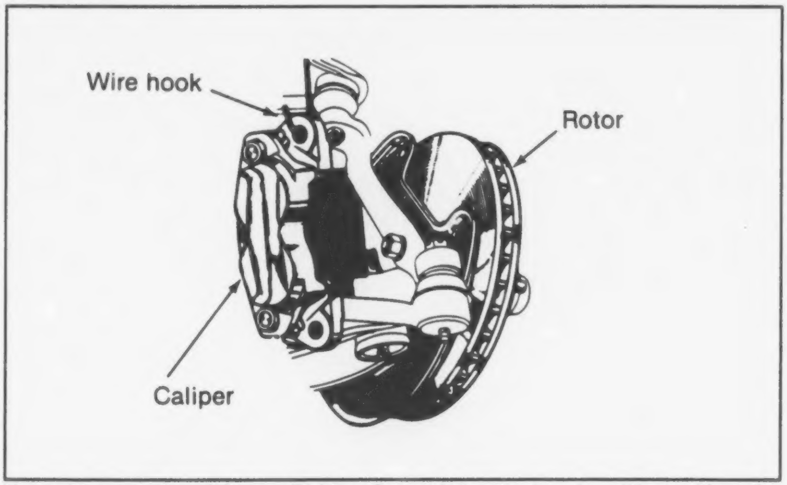
- Before beginning brake work, remove about half of the brake fluid from master cylinder reservoir and discard. This will prevent fluid overflow when pistons are pushed back into calipers.
- Before removing brake pads, check for hydraulic leaks by depressing brake pedal (with engine running on power-brake-equipped vehicles).
- Do not install new pads with another caliper removed to avoid displacing the pistons of the other caliper.

- Keep grease, oil, and brake fluid off caliper, rotor, and pad-and-lining assemblies.

- Do not press brake pedal when pads are out or caliper is off rotor.

- Never allow caliper assembly to hang by brake hose; support caliper or suspend it from frame with a strong piece of wire as shown in Figure 1

FIGURE 1



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- Make sure that caliper bleed screws can be opened.

  NOTE: If bleed screws are frozen with corrosion, it is sometimes possible to free them with penetrating oil and a small ball-peen hammer and tightening and then loosening to break loose. If they cannot be loosened, they can be drilled out and the caliper retapped for an insert, or the caliper can be replaced with a rebuilt or new unit.

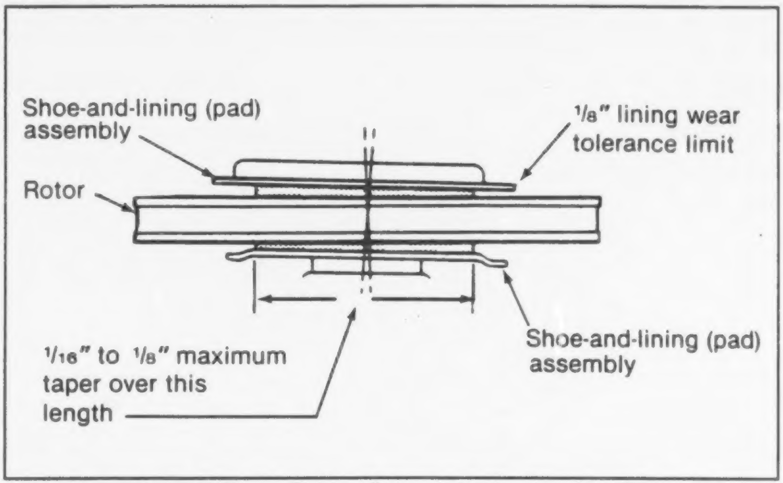
- Check brake pad wear at least every 10,000 miles under normal driving operations.

- When removing pads from calipers, note positions of shims, antirattle clips, keys, bushings, pins, etc., to facilitate reassembly.

- Replace pads when lining is worn $\frac{1}{8}$ inch above metal backing plate or $\frac{1}{16}$ inch over rivets, when disc pad lining is contaminated with brake fluid or grease, or when it is loose on the metal backing.

- Replace linings that are tapered and worn unevenly if the difference in thickness from one end of pad to other exceeds $\frac{1}{16}$ inch on fixed calipers or $\frac{1}{8}$ inch on floating calipers as shown in Figure 2.

FIGURE 2


Shoe-and-lining (pad) assembly
1/8" lining wear tolerance limit
Rotor
1/16" to 1/8" maximum taper over this length
Shoe-and-lining (pad) assembly

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- If rotor contains grooves, scoring, nicks, or deep scratches, it should be replaced or machined. See Job Sheet 4.

- Remove glazing, contamination, or light corrosion from rotor with 80-grit sandpaper.

- If installing new pads, inspect caliper assembly for leakage and rebuild or replace the caliper if necessary.

  NOTE: Because new pads are thicker than the worn-out set, they position the piston(s) deep in its bore. Therefore, part of the piston(s) that was subject to debris and corrosion will now contaminate the bore and may cause the hydraulic seal to leak.

- Always replace bushings, o-rings, antirattle clips and other small hardware to ensure a dependable brake job.

- Be very careful not to stretch or twist the brake fluid hose (keep the alignment stripe—if present—straight) and use a new copper washer in the hose connection.

- Clean all sliding surfaces to remove burrs and corrosion and lubricate where specified only with approved lubricant.

- Bleed brakes and check to be sure that the brake pedal is high and hard before road testing vehicle.

Safety precautions:

- Always use EPA-approved asbestos safety equipment and recommended protective clothing.

◆ WARNING ◆

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

- When operating the engine, be sure that transmission lever is in neutral or park and make sure that area is properly ventilated for exhaust fumes.

- Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

- Before test driving any vehicle, check the fluid level in the master cylinder and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

Job Acquisition/ Development Skills
- Master specific job task/ procedure

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

OBJECTIVE 10 **Recondition a disc brake caliper.**

INTRODUCTION

Caliper reconditioning includes all operations required to restore the caliper and its parts to the manufacturer's specifications. Frozen pistons, leaks, and damaged dust boots are all causes for caliper reconditioning.

Calipers must be removed from the vehicle when they are reconditioned. When you removed and replaced brake shoes, you removed various types of calipers, but you did not disconnect them from the hydraulic system. In most cases of caliper reconditioning, you have to remove only a brake hose or line. Because there is such a wide variety of caliper designs, however, the reconditioning procedure varies considerably. For this reason, the proper reconditioning procedure can be found only in the manufacturer's service manual. Certain general precautions and guidelines should be observed, no matter what caliper design is being serviced, and these are listed below and on the following pages.

General guidelines:

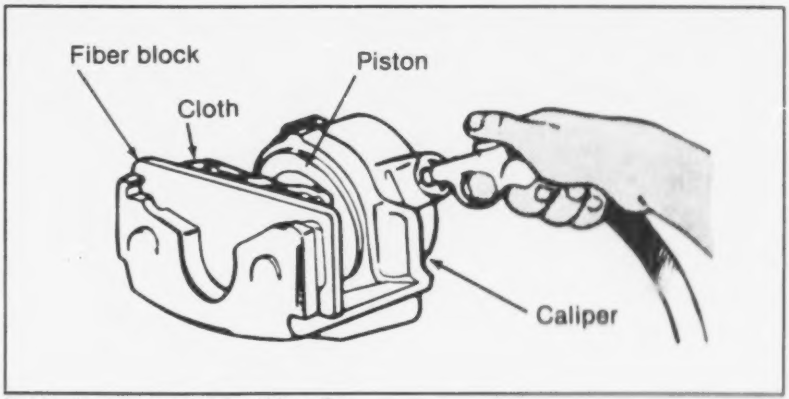
- Recondition, install, and bleed one caliper before starting work on another.

  There are two reasons for completing work on one wheel before starting the next. First, some calipers fit on either side of the vehicle; therefore, it is easy to switch them during installation. Although the calipers will fit in place, the position of the bleeder valve will not allow all air to escape from the cylinder during bleeding. Second, the caliper pistons must be removed from their cylinders, and it is much easier and safer to push them out hydraulically while they are still on the vehicle than to blow them out with air pressure on the bench.

- When reconditioning a caliper that has been removed from the vehicle, place a padded piece of cloth supported by a wooden or fiber block in caliper opening as shown in Figure 1 on the following page to protect the piston when it is blown out with compressed air.

The pistons cannot be blown out of multiple-piston calipers. To remove the pistons from these calipers, remove the caliper from the car with the two halves separated. Mount caliper in vise and use a piston puller to remove the pistons.

FIGURE 1



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- Place caliper between padded vise jaws. Avoid clamping too tightly as clamping too tightly may distort the cylinder bore so that the piston will no longer fit.

- Follow parts cleaning procedures and use cleaning products recommended by service manual. For example, the use of alcohol or alcohol-based cleaning fluids is not recommended by all manufacturers. Traces of alcohol may remain in the cylinder. Since alcohol has a low boiling point, any of it left in the cylinder might lower the boiling point of the brake fluid.

- Ignore black stains on the piston; they are caused by the piston seal and are a normal condition.

- In some cases, it may be possible to salvage a scored or pitted caliper by honing. However, most vehicle makers advise against the use of abrasives on the cylinder walls. Always consult the service manual for recommendations concerning the vehicle on which you are working.

- Use only an approved assembly lubricant. Some manufacturers recommend the use of specially formulated brake part lubricant. Others recommend the use of brake fluid. Consult the service manual for recommendations concerning the vehicle on which you are working.

- If parking brake is Delco-Moraine type, replace parking brake thrust washer, seals, and any damaged parts while caliper is removed from vehicle. (Job Sheet 7)

Safety precautions:

- Always use EPA-approved asbestos safety equipment and recommended protective clothing.

  ♦ WARNING ♦

  Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

- When operating the engine, be sure that transmission lever is in neutral or park and make sure that area is properly ventilated for exhaust fumes.

- Take care not to spill brake fluid on any chrome or painted surfaces as it will damage these finishes. Brake fluid is poisonous; avoid contact with skin and do not allow fluid to get into eyes. Brake fluid is flammable; keep brake fluid away from fire.

- Cover caliper assembly to contain fluid.

- Be very careful to keep your fingers out of the way when attempting to remove a piston with compressed air; the piston is ejected with enough force to sever a finger.

  CAUTION

  Removal of piston from caliper with compressed air can be dangerous. Follow vehicle manufacturer's instructions.

- Before test driving any vehicle check the fluid level in master cylinder and depress the brake pedal to be sure there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

EQUIPMENT AND MATERIALS

As required by procedure.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Interpret graphics and symbols

Job Acquisition/ Development Skills
- Master specific job task/ procedure

NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

JOB SHEET 3 — SERVICING DISC BRAKES

III

OBJECTIVE 11

Clean, inspect, and measure a rotor with dial indicator and micrometer.

INTRODUCTION

Disc brake problems are mainly related to improper fits and distortions of flat surfaces that can be inspected, measured, and diagnosed more accurately than the curved surfaces and shoe alignments of drum brakes.

Typical disc brake conditions that need careful inspection include *lateral runout* and *lack of parallelism*.

Runout is the distance the surface of a rotating part moves in and out during rotation. *Lateral runout* measures the surface which is perpendicular to the axis of rotation. Excess lateral runout can be caused by a warped rotor, incorrect torquing of lug nuts, warpage, or excessive heat. Excessive lateral runout causes the rotor to knock the pads back and can result in chatter, excessive pedal travel, a pumping or pulsating pedal, and vibration during braking.

Lack of parallelism is excessive variations in the thickness of the rotor. Lack of parallelism can cause pedal vibration and pulsation, excessive pedal travel, grabby braking action, and front-end vibrations.

This Job Sheet procedure is for disc brakes on *nondrive* wheels. Procedures vary for disc brakes on *drive* wheels, and you must refer to the vehicle manufacturer's instructions.

EQUIPMENT AND MATERIALS

- Vehicle
- Appropriate service manual
- Fender and seat covers
- EPA-approved asbestos safety equipment and recommended protective clothing
- Hydraulic lift or jack and jack stands
- Rubber mallet
- Replacement cotter pins
- Solvent for cleaning dust cap
- Diagonal cutting pliers
- Hub cap remover
- Torque wrench
- Shop towels and lint-free cloths

- Recommended cleaning fluid
- Dial indicator
- Micrometer
- Brake System Inspection Report Form

◆ WARNING ◆

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

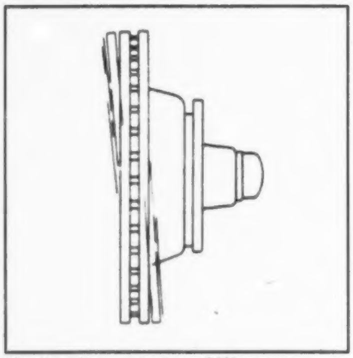
Functional Writing Skills
- Complete forms and records

Operation and Calculation Skills
- Perform metric calculations

NOTE: Be sure to note all inspection findings on your Brake System Inspection Report Form.

1. Cover fenders and seat.
2. Raise vehicle and support safely.
3. Remove tire and wheel assemblies and suspend calipers.
4. Clean rotors with solvent recommended by vehicle manufacturer.
5. To measure rotor for lateral runout, tighten the wheel spindle nut to specified rotor-checking torque, with all end play removed. (Figure 1)

FIGURE 1



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Functional Math Skills
- Make measurements

General Science Skills
- Use scientific instruments

Job Acquisition/ Development Skills
- Master specific job task/ procedure
- Practice good work habits/attitudes

6. Fasten dial indicator to suspension at a convenient place, making sure that indicator stylus contacts rotor face about 1 inch from rotor's outer edge. (Figure 2)

7. Check total indicator reading (t.i.r.) while turning rotor one full revolution; if rotor is warped beyond vehicle manufacturer's specifications, it must be replaced or resurfaced. (Job Sheet 4)

8. Measure rotor for correct parallelism by placing micrometer on the rotor about 1 inch from the rotor edge. (Figures 3 and 4)

9. Measure and record rotor thickness.

10. Repeat measuring and recording procedure at four more equally spaced points on rotor.

11. Subtract smallest reading from largest reading and compare this figure to the specification for the vehicle.

    NOTE: This specification is usually less than 0.011 inch.

FIGURE 2

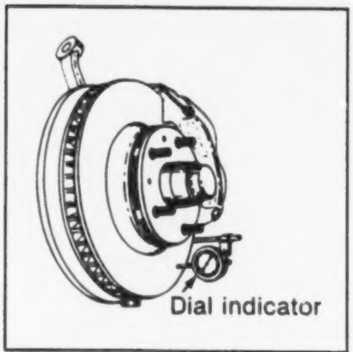

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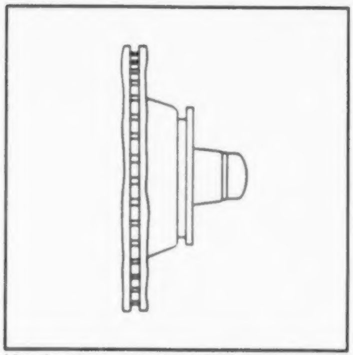
FIGURE 3



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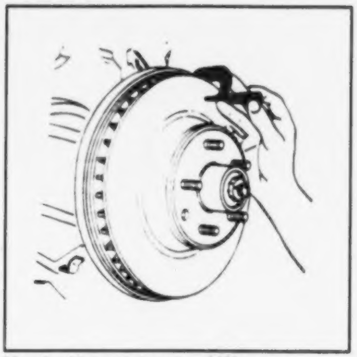
12. If rotor is excessively out of parallel, it must be replaced or resurfaced. (Job Sheet 4)

13. Readjust wheel bearings.

14. Reinstall calipers and tire and wheel assemblies, tightening lug nuts in a cross pattern just enough so that wheel is snug against hub.

15. Lower vehicle to floor.

FIGURE 4



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16. Torque lug nuts to manufacturer's specifications

17. Install wheel covers, tapping in place with rubber mallet.

18. Road test vehicle.

◆ WARNING ◆

Before test driving any vehicle, check the fluid level in the master cylinder and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

19. Clean work area and return equipment and materials to proper storage.

SERVICING DISC BRAKES

OBJECTIVE 12 **Resurface a rotor.**

INTRODUCTION

Except for those defects that require actual replacement of the rotor, most rotor defects such as scoring, runout, and incorrect parallelism are corrected by resurfacing the rotor on a brake lathe with a twin cutter tool attachment. As the rotor turns on the lathe, the twin cutter tool shaves metal from both sides of the rotor to a specified thickness.

Vehicle manufacturers specify a minimum allowable rotor thickness and this specification is stamped on the rotor. Machining a rotor until it is thinner than the specified minimum thickness could permit the rotor to wear past the safe discard point before the linings wear out. It could also cause severe overheating and, as the linings become worn, could cause the pads to be forced out far enough to jam the brakes. For these reasons, the brakes specialist should always consult the service manual for the vehicle being worked on to find the minimum allowable rotor thickness.

After a rotor has been resurfaced, it is then refaced. This removes any remaining minor imperfections and provides a nondirectional finish on the surface of the rotor. A special sanding disc is attached to the brake lathe to accomplish this task.

A rotor can be resurfaced using a disc brake lathe, or it can be resurfaced using a drum brake lathe with special refinishing attachments. The procedures for resurfacing the rotors of nondrive and drive wheels of different vehicles vary. Since the equipment and procedures used to resurface a rotor vary, always consult the appropriate vehicle service manual and lathe operating manual when performing this procedure. There are, however, certain precautions and guidelines that should always be followed when resurfacing a rotor, and they are listed below and on the following page.

General guidelines:

- Before resurfacing a rotor, consult the vehicle service manual for the minimum thickness allowed after refinishing. In some cases, the rotor is not thick enough after refinishing, and the rotor must be replaced.

- Always resurface both rotors; even if only one rotor needs resurfacing, vehicle manufacturers recommend that both be resurfaced at the same time.

- Always consult manufacturer's instructions for amount to be cut from the friction surface at one time.

- Rotors that are only lightly rusted, glazed, or scored, or those with little runout or lack of parallelism may require only one cut of the friction surfaces, rather than two or more cuts.

- Always be sure that the adapters and arbor are clean and free of metal chips and grease and that arbor is not damaged in any way. Contaminants or defects on the lathe arbor or the adapters will result in inaccurate rotor refinishing.

- Always consult the lathe manufacturer's operating manual for exact method of mounting the sanding attachment on the brake lathe.

- Do not handle the rotor with greasy hands or otherwise contaminate the friction surface of rotor after resurfacing.

Safety precautions:

- Always use EPA-approved asbestos safety equipment and recommended protective clothing.

  ◆ WARNING ◆

  Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

- Before test driving any vehicle, check the fluid level in the master cylinder and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

EQUIPMENT AND MATERIALS

As required by procedure

PROCEDURE

Research and Reference Skills
- Use standard references

Job Acquisition/ Development Skills
- Master specific job task/procedure

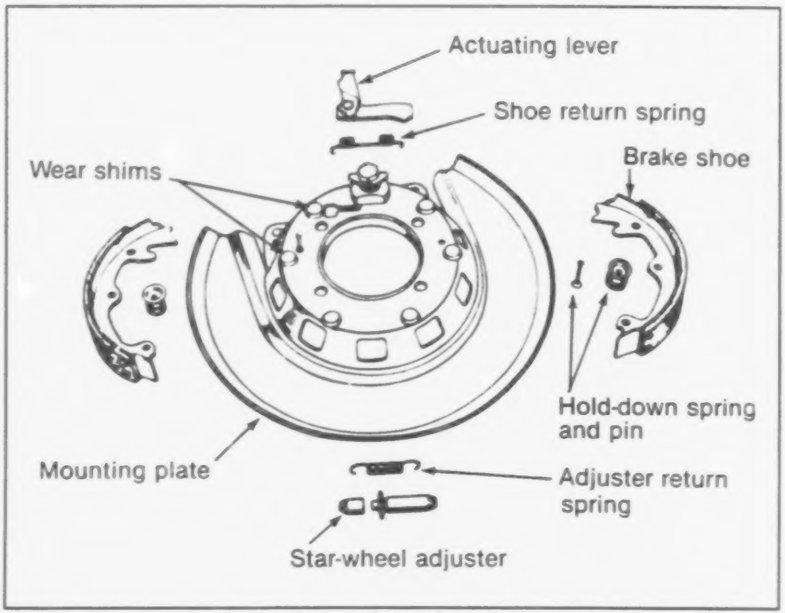
NOTE: Refer to vehicle manufacturer's service manual for make and model as equipped.

OBJECTIVE 13 **Overhaul and adjust rear disc/drum (auxiliary drum) parking brake.**

INTRODUCTION

The independent parking brake on vehicles equipped with rear disc brakes is different than the integrated parking brakes found on vehicles with rear drum brakes. With this type of parking brake, the inner surface of the rotor serves as a drum and is fitted with a small pair of drum type shoes. The components of the parking brake assembly of the rear disc/drum parking brake are shown in Figure 1 below.

FIGURE 1


Actuating lever
Shoe return spring
Brake shoe
Wear shims
Hold-down spring and pin
Mounting plate
Adjuster return spring
Star-wheel adjuster

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Shoe to drum clearance is adjusted manually at the star wheel just as it is in regular drum brakes. When servicing this type of parking brake, however, the technician should check for the following:

- Free movement of the parking brake cables in the conduits
- Worn equalizer and linkage parts

- Broken strands in the cables

This Job Sheet will give you practice in the skills necessary to overhaul and adjust the rear disc/drum parking brake.

EQUIPMENT AND MATERIALS

- Vehicle
- EPA-approved asbestos safety equipment and protective clothing
- Fender and seat covers
- Brake parts washer and approved solvent
- Star-wheel adjusting tool
- Brake spring pliers
- Approved lubricant
- Appropriate replacement parts
- Shop cloths
- Hydraulic lift or jack and jack stands
- Rubber mallet
- Basic hand-tool set
- Appropriate service manual

◆ WARNING ◆

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

1. Cover fenders and seats.

2. Release parking brake.

3. Raise vehicle and support safely.

4. Remove rear tire and wheel assemblies.

- Interpret graphics and symbols

Job Acquisition/ Development Skills

- Master specific job task/ procedure
- Practice good work habits/attitudes

5. Remove rear wheel parking brake assembly, backing off adjustment of shoes, if necessary, by following vehicle manufacturer's instructions.

   NOTE: It may be necessary to adjust star wheel in order to remove the rear wheel parking brake assembly.

6. Spread shoes and remove adjuster assembly, taking care not to damage shims on mounting plate during disassembly.

   CAUTION

   Be very careful not to damage the wear shims on the mounting plate during any step of this procedure. If the shims are damaged, the entire mounting plate assembly must be replaced.

7. Remove adjuster return spring.

8. Remove hold-down springs by pushing down on spring and sliding pin over until it can be removed with appropriate tool through hole at end of slot.

9. Remove shoe return spring.

10. Remove both shoes.

11. Clean and inspect star wheel adjuster assembly; lubricate threads with approved lubricant.

12. Clean and inspect wear bracket and wear shims.

    NOTE: If wear bracket or wear shims are damaged, the entire mounting plate must be replaced.

13. Clean and inspect rubber boot; if it is worn or cracked, replace.

14. Clean and inspect hardware.

15. Lubricate wear bracket and shims with approved lubricant.

16. Reinstall shoes, making sure that actuating lever and strut assembly are positioned on wear shims.

17. Reinstall shoe return spring.

18. Reinstall hold down springs and pins.

19. Reinstall adjuster return spring.

20. Reinstall star wheel adjuster.

21. Position parking brake assembly on hub and hold down with two lugs.

22. Adjust shoe to drum clearance by tightening adjuster until rotor cannot be moved and then backing off ten notches from this fully expanded position.

23. Repeat steps 5 through 22 for other rear wheel.

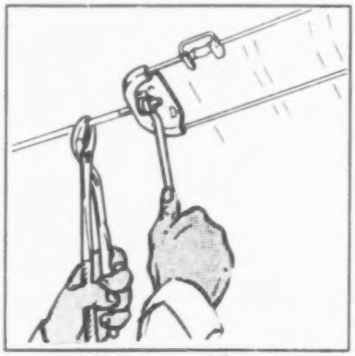
24. Apply parking brake lever or pedal from inside the vehicle to position specified in vehicle manufacturer's service manual.

25. Adjust parking brake cable link at equalizer underneath vehicle to produce light drag. (Figure 2)

26. Complete installation of both parking brake assemblies, following instructions in service manual.

27. Reinstall rear tire and wheel assemblies, tightening lug nuts in a cross pattern just enough so that wheel is snug against hub.

FIGURE 2



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28. Release parking brake pedal or lever.

29. Rotate rear wheels by hand to check for drag; no drag should be noticed.

30. Lower vehicle to floor.

31. Torque lug nuts to manufacturer's specifications.

32. Install wheel covers, tapping in place with rubber mallet.

33. Test parking brake for proper operation.

34. Road test vehicle.

◆ WARNING ◆

Before test driving any vehicle, check the fluid level in the master cylinder and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

35. Clean work area and return equipment and materials to proper storage.

JOB SHEET 6

SERVICING DISC BRAKES

III

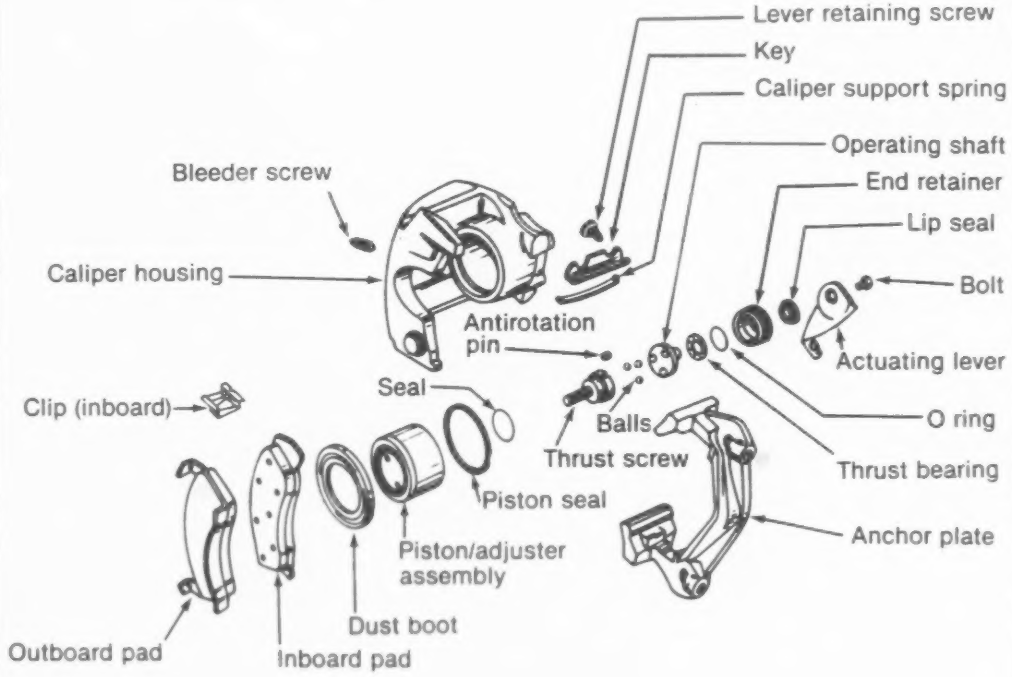
OBJECTIVE 14

Overhaul Kelsey-Hayes type rear disc brake/parking brake assembly.

INTRODUCTION

Kelsey-Hayes rear disc brakes have been used on some Ford vehicles since 1975. This rear disc caliper assembly is similar to the front brake caliper except for an added parking brake and adjuster mechanism that is actuated by the parking brake cable. (Figure 1).

FIGURE 1


Lever retaining screw
Key
Caliper support spring
Operating shaft
End retainer
Lip seal
Bolt
Bleeder screw
Caliper housing
Antirotation pin
Actuating lever
Seal
Clip (inboard)
Balls
O ring
Thrust screw
Thrust bearing
Piston seal
Anchor plate
Piston/adjuster assembly
Dust boot
Outboard pad
Inboard pad

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When the parking brake is applied, the lever rotates an operating shaft. There are three balls located in pockets between the operating shaft head and the thrust screw. As the shaft rotation forces these balls up raised areas on the thrust screw head, the thrust screw drives the piston and pad against the rotor. The pressure of the piston on the brake pads holds the rotor in place, acting as a parking brake. An automatic adjuster in the piston assembly moves on the thrust screw to compensate for pad wear and to maintain proper internal clearances.

EQUIPMENT AND MATERIALS

- Vehicle
- EPA-approved asbestos safety equipment and recommended protective clothing
- Brake parts washer and approved solvent
- Brake adjusting tool
- Piston removing tool
- Magnet or tweezers
- Appropriate replacement parts
- Shop cloths
- Hydraulic lift or jack and jack stands
- Basic hand-tool set
- Isopropyl alcohol
- Source of compressed air
- Approved brake fluid
- Dust boot installing tool
- Bench vise
- Allen wrench, ¼-inch
- Silicone grease
- Torque wrench
- Brake bleeding equipment
- Appropriate service manual

◆ WARNING ◆

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

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PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

General Science Skills
- Use scientific instruments

Job Acquisition/ Development Skills
- Master specific job task/ procedure
- Practice good work habits/attitudes

1. Cover fenders and seats.
2. Raise vehicle and support safely.
3. Remove tire and wheel assembly.
4. Disconnect parking brake cable from lever, using care to avoid kinking or cutting cable or return spring.
5. Disconnect hydraulic brake line from back of caliper and plug openings.

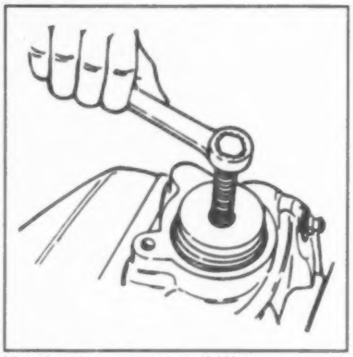
   NOTE: If the line connection is frozen, disconnect the line at the junction block. Plug opening and remove caliper with brake lines attached.
6. Remove caliper from vehicle, following procedure outlined in service manual.
7. Place caliper on work bench and remove caliper end retainer. (Figure 1)
8. Lift out operating shaft, thrust bearing, and balls. (Figure 1)
9. To remove antirotation pin with magnet or tweezers, adjust piston out from caliper bore with piston remover until piston protrudes from housing at least 1 inch.
10. Push piston back into caliper housing with adjusting tool; with tool in position on caliper, hold tool shaft in place and rotate handle counterclockwise until thrust screw clears antirotation pin.
11. Remove antirotation pin.
12. Remove thrust screw by rotating it counterclockwise with ¼-inch allen wrench.

13. Remove piston-adjuster assembly by installing piston remover through back of caliper housing and pushing piston out. (Figure 2)

CAUTION

Take care not to damage the polished surface in the thrust screw bore and do not press on or attempt to remove the adjuster. It is press-fitted in the piston.

FIGURE 2



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14. Remove and discard all rubber parts (boot and seals).

15. Clean all metal parts with isopropyl alcohol; clean and dry passages with compressed air.

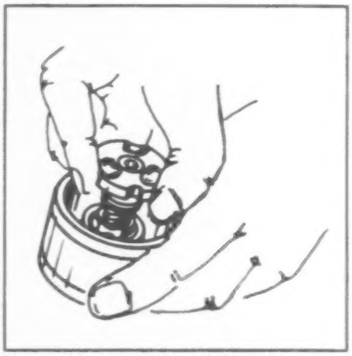
16. Inspect caliper bores for damage or excessive wear; if thrust screw bore is rough or pitted or if piston is pitted, scored, or has worn-off chrome plating, replace piston adjuster assembly.

17. Inspect adjuster, if adjuster is loose in piston, appears high in piston, or is damaged or if brake adjustment problems have occurred during normal operation, replace piston/adjuster assembly.

    NOTE: The adjuster must be bottomed in the piston to be properly seated and to provide consistent parking-brake function.

18. Assemble thrust screw into piston assembly. (Figure 3)

FIGURE 3



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19. Pull the two pieces apart by hand approximately ¼ inch and then release them.

    NOTE: When pulling the two pieces apart, the brass drive ring must remain stationary, causing the nut to rotate. When releasing the two parts, the nut must remain stationary and the drive ring must rotate.

20. If action of components does not follow pattern described above, replace piston/adjuster assembly.

21. Inspect ball pockets, threads, grooves, and bearing surfaces of thrust screws and operating shaft for wear, pitting, or brinnelling, if any parts are worn or damaged, replace.

22. Inspect thrust bearing, if it is badly corroded, pitted, or worn, replace.

23. Inspect bearing surface of end plug; if worn or brinnelled, replace.

    NOTE: A polished appearance on the bearing surface is acceptable if there is no sign of erosion on the surface.

24. Inspect lever; if damaged, replace.

25. Apply a coat of clean, approved brake fluid to new caliper piston seal and install it in cylinder bore, making sure that seal is not twisted and that it is seated fully in groove.

26. Install new dust boot by seating flange squarely in outer groove of caliper bore.

27. Coat piston/adjuster assembly with clean, approved brake fluid and install it in cylinder bore, spreading dust boot over piston as it is installed and seating dust boot in piston groove.

28. Install caliper in vise and fill piston/adjuster assembly with recommended brake fluid to bottom edge of thrust screw bore.

29. Install thrust screw by turning it into piston/adjuster assembly with ¼-inch allen wrench until top surface of thrust screw is flush with bottom of threaded bore.

    CAUTION

    Use care to avoid cutting o-ring seal.

30. Index thrust screw so that notches on screw and caliper housing are aligned and install antirotation pin.

    NOTE: The thrust screw and operating shaft are not interchangeable from side to side. The pocket surface of the operating shaft and thrust screw are stamped with the letter R (right) or L (left).

31. Place a ball in each of the three pockets of thrust screw and apply a liberal amount of silicone grease to all components of parking brake mechanism.

32. Install operating shaft on balls.

33. Coat thrust bearing with silicone grease and install it on operating shaft.

34. Install new lip seal and o-ring in end retainer.

35. Coat o-ring seal and lip seal with light film of silicone grease and install end retainer in caliper, holding operating shaft firmly seated against internal mechanism to prevent mislocation of balls.

36. If lip seal is pushed out of position, reseat the seal.

37. Torque end retainer to specifications.

    NOTE: This is usually 75 to 95 foot-pounds.

38. Install parking brake lever on its keyed spline, making sure that it points down and rearward so the parking brake cable can pass freely under axle.

39. Torque lever retaining screw to specifications; check to make sure that lever can rotate freely after torquing.

    NOTE: Torquing specifications are usually 16 to 22 foot-pounds.

40. Holding caliper in vise, bottom piston with piston installing tool.

41. Install caliper on vehicle and reconnect brake lines as specified in service manual, taking care not to twist or kink them.

    NOTE: If connection at junction block was opened, use two new copper washers when reinstalling line.

42. Repeat steps 3 through 37 for other wheel.

43. Bleed rear brake system.

44. Connect parking brake cable and adjust if necessary.

45. Reinstall tire and wheel assemblies, tightening lug nuts in cross pattern just enough so that wheel is snug against hub.

46. Lower vehicle to floor.

47. Torque lug nuts to manufacturer's specification.

48. Install wheel covers, tapping in place with rubber mallet.

49. Test parking brake for proper operation.

50. Road test vehicle.

    ◆ WARNING ◆

    Before test driving any vehicle, check the fluid level in the master cylinder and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

51. Clean work area and return equipment and materials to proper storage.

JOB SHEET 7

SERVICING DISC BRAKES

III

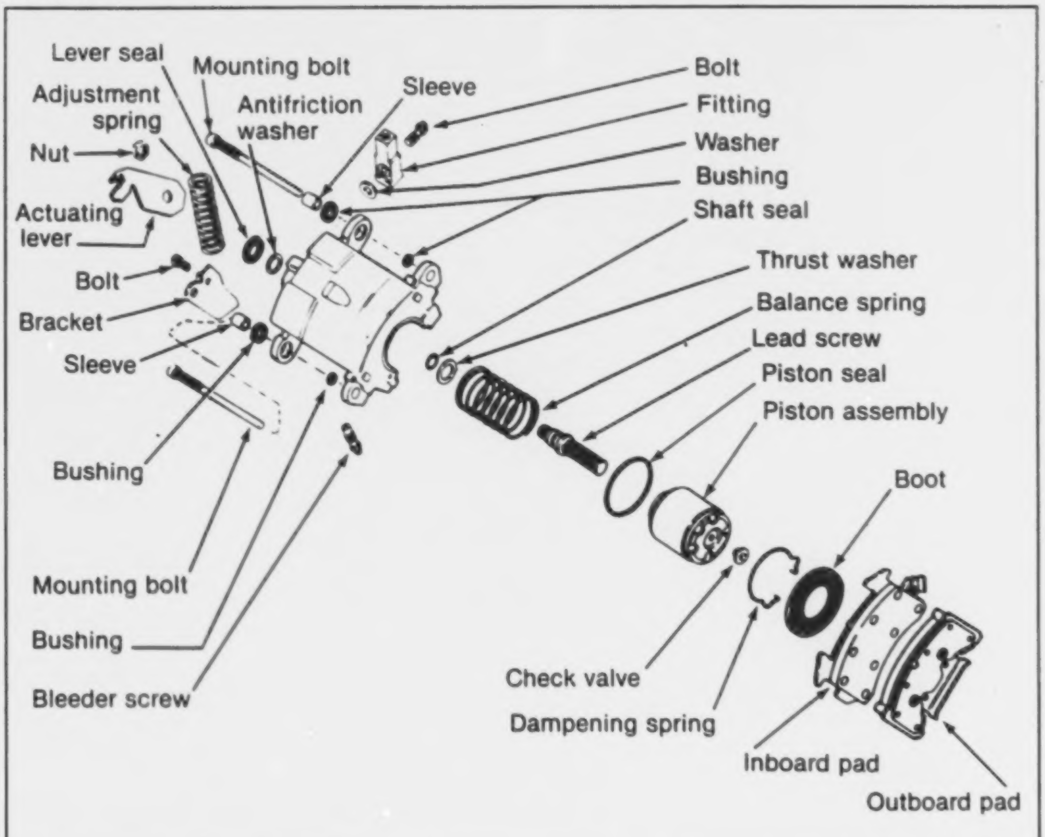
OBJECTIVE 15

Overhaul GM Delco-Moraine type rear disc brake/parking brake assembly.

INTRODUCTION

As with the Kelsey-Hayes rear disc brakes, the GM Delco-Moraine rear brake caliper is similar to the front brake caliper except for the addition of a parking brake mechanism. On this design, the parking brake is operated through a lever on the inboard side of the caliper which is connected to the parking brake cable. The actuating lever is connected to a high lead screw that passes through a nut in the piston. Rotation of the lever moves the piston along the screw, thus engaging the parking brake. (Figure 1)

FIGURE 1



Lever seal
Mounting bolt
Adjustment spring
Antifriction washer
Sleeve
Nut
Actuating lever
Bolt
Bracket
Sleeve
Bushing
Mounting bolt
Bushing
Bleeder screw
Bolt
Fitting
Washer
Bushing
Shaft seal
Thrust washer
Balance spring
Lead screw
Piston seal
Piston assembly
Boot
Check valve
Dampening spring
Inboard pad
Outboard pad

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The nut in the piston is spring loaded, permitting piston travel during hydraulic braking. As lining wear allows the piston to move farther out of the bore, the nut is rotated along the lead screw by means of an adjustment spring. Because of this spring action, there is no manual adjustment of this type of parking brake. However, when the caliper is overhauled, the parking brake components should be replaced.

Normally there is no reason to disassemble the parking brake mechanism except during pad replacement or servicing of the regular disc brake. However, it is necessary to remove the actuating lever to remove the caliper from the vehicle.

EQUIPMENT AND MATERIALS

- Vehicle
- EPA-approved asbestos safety equipment and recommended protective clothing
- Shop cloths
- Hydraulic lift or jack and jack stands
- Basic hand-tool set
- C-clamp
- Silicone grease
- Hex wrench
- Torque wrench
- Piston installer
- Appropriate replacement parts
- Brake bleeding equipment
- Approved brake fluid
- Isopropyl alcohol
- Dust boot installing tool
- Seal driver
- Appropriate service manual

◆ WARNING ◆

Many brake components may contain asbestos fibers. Breathing asbestos dust is very harmful to your health. Asbestos fibers can irritate the lungs and cause asbestosis and cancer. Use approved safety equipment and wear recommended protective clothing during brake service. Strictly follow all asbestos safety rules.

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

Research and Reference Skills
- Use standard references

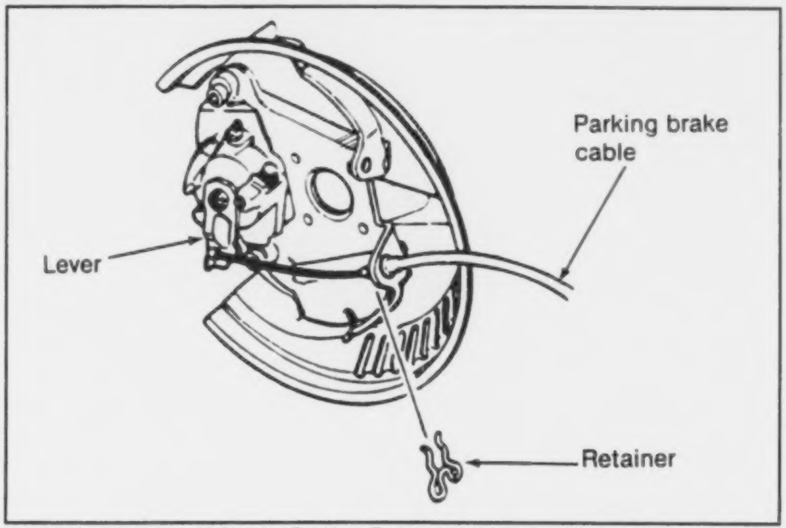
Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

General Science Skills
- Investigate/apply technology

Job Acquisition/ Development Skills
- Master specific job task/ procedure
- Practice good work habits/attitudes

1. Cover fenders and seats.
2. Raise vehicle and support safely.
3. Remove tire and wheel assembly and install one wheel lug—flat side toward rotor—to prevent rotor from falling when caliper is removed.
4. Loosen tension on parking brake cable at equalizer.
5. Remove cable from parking brake actuating lever. (Figure 2)

FIGURE 2



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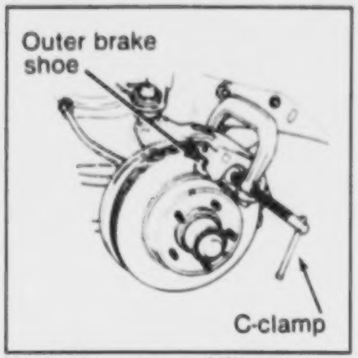
6. Remove cable bracket from caliper.
7. Hold actuating lever in place and remove locknut.
8. Remove actuating lever, return spring, lever seal, and antifriction washer.

9. Position C-clamp over caliper, with solid side against back of caliper assembly and screw side against back of outer pad as shown in Figure 3.

CAUTION

Do not place clamp on actuating lever screw.

FIGURE 3



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10. Disconnect hydraulic brake line from back of caliper and plug openings.

NOTE: If the line connection is frozen, disconnect the line at the junction block. Plug openings and remove caliper with brake lines attached.

11. Remove the two mounting bolts that hold caliper to support bracket.

12. Lift caliper off rotor and drain fluid through brake bleeder into appropriate container; dispose of brake fluid properly.

13. Lubricate area under actuating lever seal with silicone grease.

14. Install new antifriction washer, new seal, and actuating lever on hex nut, with arm pointing downward.

15. Rotate lever toward front of vehicle and hold in this position while torquing it to 25 foot-pounds; then rotate lever back to its stop.

16. Install lever return spring and remove C-clamp.

CAUTION

Install the correct return spring. Return springs are not interchangeable and are color-coded—red for the right side and black for the left side.

17. Rotate lever back and forth to remove piston.

18. If piston does not come out, remove nut, lever seal, and washer and turn piston out using a wrench on the hex screw, turning clockwise on right-hand caliper and counterclockwise on left-hand caliper.

19. Taking care not to scratch cylinder bore, remove piston and balance spring, actuating screw, boots, and seals.

20. Clean parts and housing with isopropyl alcohol and blow dry with compressed air.

21. Check bore and piston for scratches and pits, if damage is found, replace piston.

22. Check cavity under check valve; if brake fluid is found in cavity, replace piston assembly.

23. Install new piston seal in bore.

24. Install boot on piston assembly.

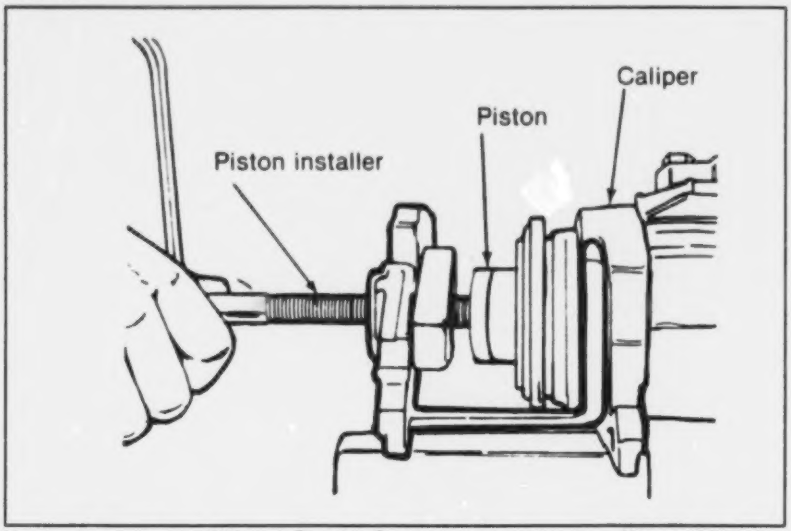
25. Install new thrust washer—with Teflon surface toward housing—and new o-ring seal on screw; lubricate with brake fluid.

26. Fit screw into piston assembly, noting that pistons and screws are marked R and L to match letters on caliper.

27. Fit balance spring into piston retainer.

28. Use piston installer to install piston straight into housing. (Figure 4)

FIGURE 4



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29. Before removing piston installer, install antifriction washer lubricated with silicone grease, lever seal, lever, and locknut.

30. Push lever down, rotate it forward, tighten locknut, and return lever to its stop.

31. Remove piston installer.

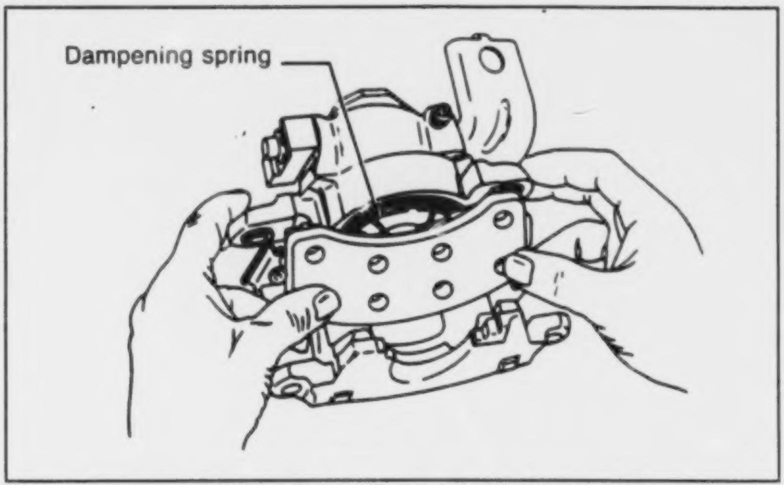
32. Use seal driver to install piston seal.

33. Install dampening spring on pad plate.

34. Position new inner pad on piston as shown in Figure 5, making sure the D-shaped tab on pad fits in indentation provided.

    NOTE: If the piston needs to be rotated, use piston remover to rotate it.

FIGURE 5



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35. Use large pliers to seat pad ears over caliper.

36. Lubricate o-ring bushings, bushing grooves, sleeves, and tips of both mounting bolts with silicone grease.

37. Position caliper over rotor and install mounting bolts; tighten mounting bolts to service manual specifications.

38. Reconnect brake lines, taking care not to twist or kink them.

    NOTE: If connection at junction block was opened, use two new copper washers when reinstalling line.

39. Repeat steps 3 through 38 for other wheel.

40. Take up piston clearance by actuating parking brake several times.

41. Bleed rear brake system.

42. Pump brake pedal to seat the pads against rotors.

43. Connect parking brake cable to actuating lever on each wheel.

44. Work parking brake pedal or lever back and forth and then check to see whether the lever returns all the way to the stop; if the lever does not return, more slack is needed—adjust it at equalizer nut.

    NOTE: If the lever still does not return, even with plenty of cable slack, check the return spring and piston and screw assembly and replace as necessary.

45. On one wheel at a time, remove lug nut that was used to prevent rotor from falling off when caliper was removed.

46. Reinstall tire and wheel assemblies, tightening lug nuts in a cross pattern just enough so that wheel is snug against hub.

47. Lower vehicle to floor.

48. Torque lug nuts to manufacturer's specifications.

49. Install wheel covers, tapping in place with rubber mallet.

50. Fill master cylinder with fresh brake fluid.

51. Obtain a high, hard pedal by pumping the brake pedal several times firmly but slowly.

52. Road test vehicle.

    ◆ WARNING ◆

    Before test driving any vehicle, check the fluid level in the master cylinder and depress the brake pedal to be sure that there is adequate pedal reserve. Next, make a series of low-speed stops to be sure that the brakes are safe for road testing.

53. Clean work area and return equipment and materials to proper storage.

PRACTICAL TEST 1

SERVICING DISC BRAKES

III

JOB SHEET 1

Remove, clean, inspect, and reinstall caliper assembly and brake pads.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed caliper assembly and brake pads following procedure outlined in vehicle manufacturer's service manual.	___	___
3. Properly supported removed caliper.	___	___
4. Cleaned appropriate parts as recommended.	___	___
5. Replaced or repaired parts as necessary.	___	___
6. Completed service correctly.	___	___
7. Observed safety rules and precautions.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

SERVICING DISC BRAKES

JOB SHEET 2

Recondition a disc brake caliper.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Disassembled caliper following procedure outlined in vehicle manufacturer's service manual.	___	___
3. Cleaned appropriate parts as recommended in vehicle manufacturer's service manual.	___	___
4. Replaced or repaired parts as necessary.	___	___
5. Completed service correctly.	___	___
6. Observed safety rules and precautions.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training

3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required

2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill

1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 3 — SERVICING DISC BRAKES — III

JOB SHEET 3

Clean, inspect, and measure a rotor with dial indicator and micrometer.

Student's name ____________________ Date ________

Evaluator's name ____________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Measured rotor for correct runout and parallelism following outlined procedure.	___	___
3. Correctly determined if rotor should be replaced or refinished.	___	___
4. Completed service correctly.	___	___
5. Observed safety rules and precautions.	___	___
6. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

PRACTICAL TEST 4

SERVICING DISC BRAKES

III

JOB SHEET 4

Resurface a rotor.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Mounted rotor on lathe following procedure outlined in lathe manufacturer's operating manual.	___	___
3. Consulted vehicle manufacturer's service manual and correctly determined if rotor could be resurfaced or if it should be replaced.	___	___
4. Resurfaced rotor following procedure outlined in the vehicle manufacturer's service manual and lathe manufacturer's operating manual.	___	___
5. Completed service correctly.	___	___
6. Observed safety rules and precautions.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 5

Overhaul and adjust rear disc/drum (auxiliary drum) parking brake.

Student's name ______________________ Date ________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed and disassembled rear wheel parking brake assembly following manufacturer's instructions.	___	___
3. Cleaned and inspected parts following outlined procedure.	___	___
4. Replaced parts as necessary.	___	___
5. Reassembled and adjusted parking brake assembly following outlined procedure.	___	___
6. Reinstalled parking brake assembly following outlined procedure.	___	___
7. Completed service correctly.	___	___
8. Observed safety rules and precautions.	___	___
9. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 6

Overhaul Kelsey-Hayes type rear disc brake/parking brake assembly.

Student's name ______________________ Date ________

Evaluator's name ______________________ Attempt no. ____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Removed caliper and parking brake following service manual procedure.	___	___
3. Cleaned and inspected parts following outlined procedure.	___	___
4. Replaced parts as necessary.	___	___
5. Installed caliper and parking brake parts following outlined procedure.	___	___
6. Completed service correctly.	___	___
7. Observed safety rules and precautions.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training
3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required
2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill
1 **Unskilled** - Is familiar with process, but is unable to perform job

JOB SHEET 7

Overhaul GM Delco-Moraine type rear disc brake/parking brake assembly.

Student's name ______________________ Date ________

Evaluator's name ______________________ Attempt no. ___

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under Process Evaluation must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Prepared and removed caliper and parking brake following outlined procedure.	___	___
3. Cleaned and inspected parts following outlined procedure.	___	___
4. Replaced parts as necessary.	___	___
5. Installed caliper and parking brake parts following outlined procedure.	___	___
6. Completed service correctly.	___	___
7. Observed safety rules and precautions.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Performance Evaluation Key below.

PERFORMANCE EVALUATION KEY

4 **Skilled** - Can perform job with no additional training

3 **Moderately Skilled** - Has performed job during training program; limited additional training may be required

2 **Limited Skill** - Has performed job during training program; additional training is required to develop skill

1 **Unskilled** - Is familiar with process, but is unable to perform job

Name ______________________ Score ________

OBJECTIVE 1

Recognize definitions of terms associated with disc brakes by choosing the correct definitions from lists of three choices. Write the letter of the correct definition in the blank.

_____ 1. **disc brake**

- a. Brake design in which brake pads contract against a round, flat braking surface to produce braking action
- b. Brake using a ring and curved shoes that expand to contact the inside wall of the ring and stop the vehicle
- c. Brake using an external band that contracts to apply friction to a bearing and stop the vehicle

_____ 2. **friction**

- a. Resistance to heat buildup between two bodies in contact
- b. Resistance to relative motion between two bodies in contact
- c. Resistance to kinetic energy between two bodies in contact

_____ 3. **inboard shoe**

- a. Shoe on wheel-cover side of brake disc
- b. Shoe on vehicle-frame side of brake disc
- c. Shoe on piston side of brake disc

_____ 4. **outboard shoe**

- a. Shoe on a wheel-cover side of brake disc
- b. Shoe on vehicle-frame side of brake disc
- c. Shoe on piston side of brake disc

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_____ 5. **pad wear indicator**

a. Thin, metal tab bent so that it contacts rotor and squeals when lining wears to point where it needs to be replaced
b. Thin piece of metal embedded in pad so that it contacts rotor and squeals when lining wears to a point where it needs to be replaced
c. Computerized sensor that beeps when pad lining wears to the point where it needs to be replaced

_____ 6. **scoring**

a. Light abrasive damage spread over a large area
b. Wear damage from multiple scratches
c. Light corrosive damage spread over a large area

_____ 7. **scuffing**

a. Light corrosive damage spread over a large area
b. Wear damage from multiple scratches
c. Light abrasive damage spread over a large area

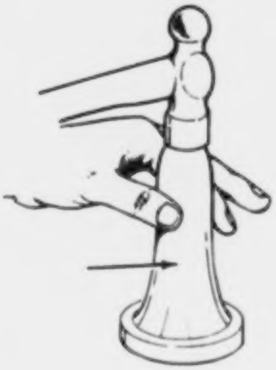
_____ 8. **vane**

a. Thin bridge between two reservoirs in dual master cylinder
b. Thin bridge between the two disc surfaces of a ventilated disc brake rotor
c. Thin bridge between the two piston surfaces of a ventilated caliper

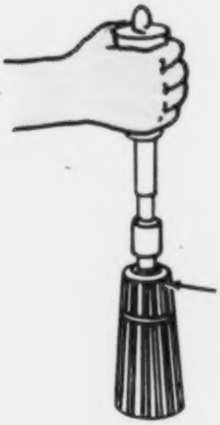
May be photocopied for student use

OBJECTIVE 2

Recall specialty tools used to service disc brakes by writing the name of the tool when given an illustration. Write the correct names for the disc brake specialty tool shown on the blank following the illustration.



1. ____________________



2. ____________________

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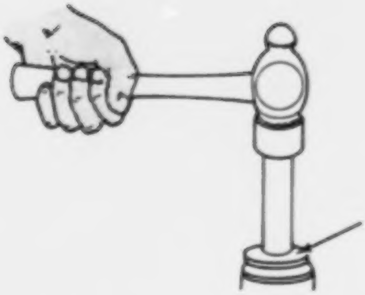
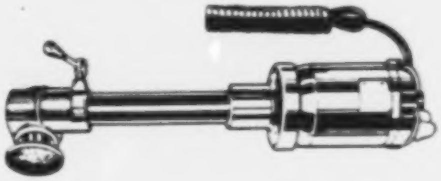
600



3. ______________________________



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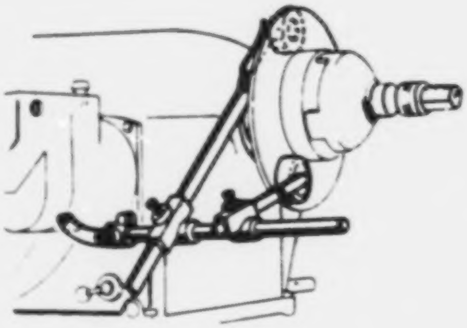
4. ______________________________



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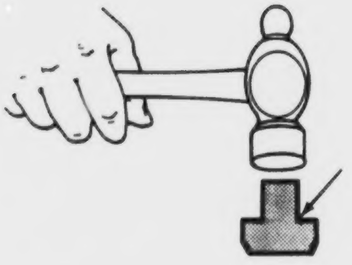
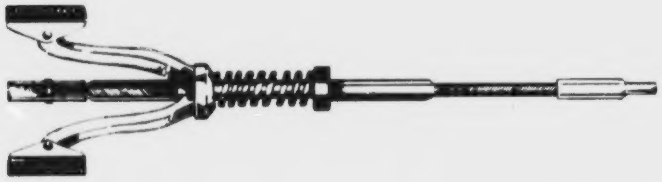
5. ______________________________

May be photocopied for student use

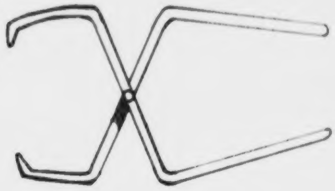
601



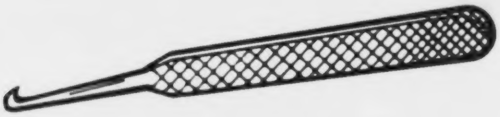
6. ____



7. ____

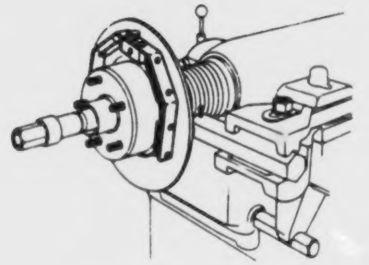


8. ____



9. ____

May be photocopied for student use.



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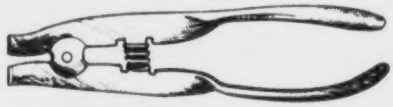
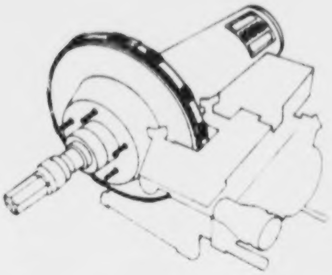
10. ______________________________



11. ______________________________



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12. ______________________________

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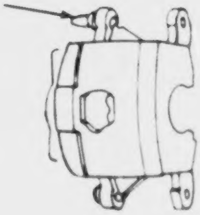
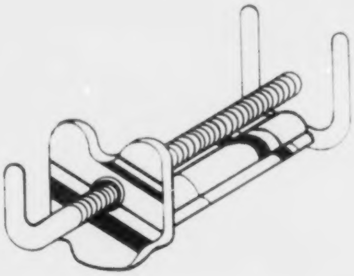
603



13. ______________________________

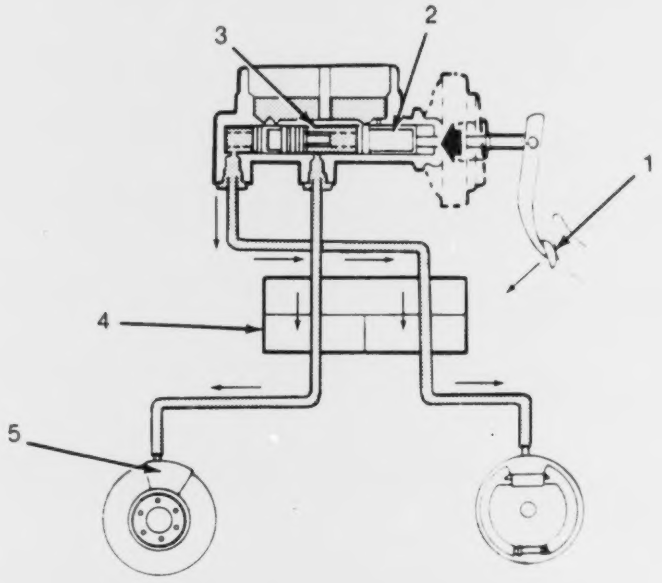


14. ______________________________

May be photocopied for student use.

OBJECTIVE 3

Recall the steps of disc brake operation by listing the steps in order when given a numbered illustration. List the steps of disc brake operation in the order numbered on the illustration below.



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1. ____

____

2. ____

____

3. ____

____

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4. ____

____

5. ____

____

OBJECTIVE 4

Recall descriptions of types of disc brake calipers by writing the correct descriptions of each. Write the description for each of the types of disc brake calipers listed below.

Fixed caliper — ____

____

____

____

Floating caliper — ____

____

____

____

Sliding caliper — ____

____

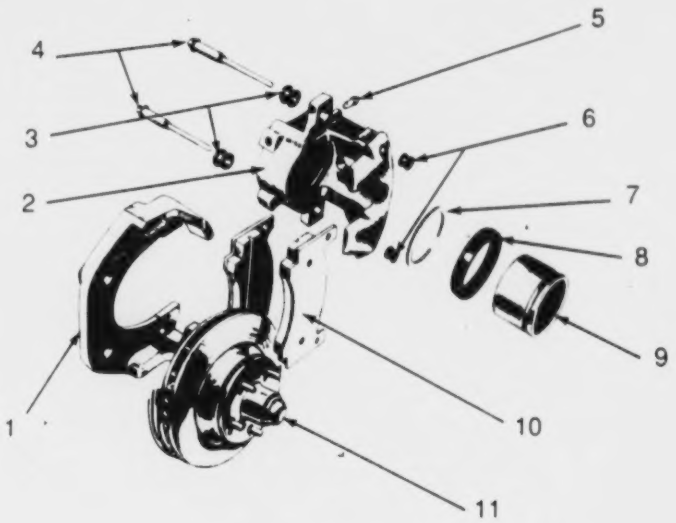
____

____

May be photocopied for student use.

OBJECTIVE 5

Recall the parts of a typical floating caliper assembly by labeling the parts on an illustration. Write the correct names in the blanks.



1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________

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007

OBJECTIVE 6

Recall the advantages of disc brake design by writing the advantages. Write the advantages in the spaces below.

- ____
  ____
- ____
  ____
- ____
  ____
- ____
  ____
- ____
  ____

OBJECTIVE 7

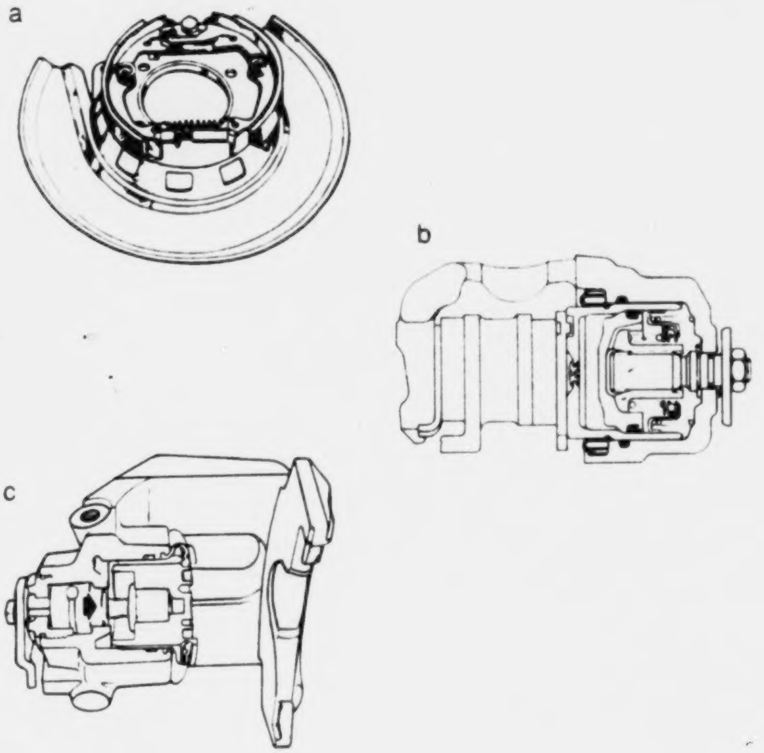
Recognize types of parking brakes used on vehicles with rear disc brakes by matching illustrations of types of parking brakes to their correct descriptions. Look at the illustrations on the following page and write the correct letters in the blanks.

_____ 1. **GM Delco-Moraine** — Mechanically operated lever connected to a high lead screw—which is passed through a nut in the piston—moves piston along screw to engage brake; integral part of regular brake.

_____ 2. **Kelsey-Hayes (Ford) sliding caliper** — Mechanically operated lever works ball-and-ramp device within parking brake to force pads against rotor; integral part of regular brake.

_____ 3. **Rear disc drum (auxiliary drum)** — Cable-operated parking brake with small 6½-inch diameter servo-type brake with star-wheel adjuster; located within rotor hub, independent of regular brake

May be photocopied for student use.



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WRITTEN TEST ANSWERS

SERVICING DISC BRAKES

III

OBJECTIVE 1

1. a
2. b
3. b
4. a
5. a
6. b
7. c
8. b

OBJECTIVE 2

1. Dust boot installing tool
2. Bearing race remover
3. Seal driver
4. Disc rotor grinder
5. Rotor silencer for use on nonventilated rotors
6. Bearing race driver
7. Caliper cylinder bore hone
8. Dust cap removing tool
9. Piston seal remover
10. Rotor silencer for use when rotor is machined on one side at a time
11. Piston remover
12. Rotor silencing band for use with ventilated rotor
13. Caliper sleeve removing and installing tool
14. Piston installer

OBJECTIVE 3

1. Brake pedal is depressed.
2. Pushrod forces primary piston in master cylinder forward.
3. Fluid in primary cylinder is pressurized to apply front (disc) brakes.
4. Brake valve is used to delay (meter) front brake application and proportion rear pressure to front pressure on some models.
5. Piston(s) in caliper forces brake shoe against rotor, thus slowing wheel rotation.

OBJECTIVE 4

Fixed caliper — is rigidly bolted directly to steering knuckle; usually has four pistons, two on each side of rotor

Floating caliper — is mounted on bolts through rubber bushings that permit it to move; has one large piston, and the braking force is exerted against caliper adapter

Sliding caliper — is mounted on machined ways that allow it to move from side to side in caliper adapter, which also receives braking force; has one or two pistons

OBJECTIVE 5

1. Caliper adapter
2. Caliper
3. Bushings
4. Mounting bolts
5. Bleeder screw
6. Bushings
7. Seal
8. Boot
9. Piston
10. Shoe and lining (pad)
11. Disc and hub assembly

OBJECTIVE 6

- Are resistant to heat face
- Are resistant to water fade
- Provide more straight-line stops
- Adjust automatically and can be equipped with a pad wear indicator
- Are easier to service than drum brakes

OBJECTIVE 7

1. b
2. c
3. a

OBJECTIVE SHEET

SERVICING ANTILOCK BRAKE SYSTEMS

IV

INTRODUCTION

Antilock brake systems are designed to keep vehicles from skidding by preventing wheel lockup. There are several different versions of antilock brake systems, but in theory and operation, they are very similar. Most of these systems are self diagnostic, self-testing and virtually trouble free, and service of these systems is generally quite easy. Occasionally a technician will encounter some problems, but with the proper manuals and equipment and a common sense approach to the symptoms, repair will not be difficult.

Antilock brakes have been used for years on large airplanes but have only been widely used on passenger vehicles since 1978. Mercedes-Benz and BMW used a Bosch system at that time. Ford and Buick experimented with an antiskid system in the late 60s, but it was found to be troublesome and not very effective. Domestic manufacturers began to use the Bosch and Teves systems on luxury cars in the early 80s. Rear wheel antilock systems were installed on many light trucks and vans in 1986. They reduce rear wheel skidding which was common on light rear end pickup trucks.

PREREQUISITES

Before studying this unit, the student must have successfully completed units 1 through 3, *Brakes Specialist.*

UNIT OBJECTIVE

After completing this unit, the student will be able to diagnose antilock brake system problems and service antilock brake systems. The student will demonstrate these competencies by completing the assignment sheets, job sheets, and written test with a minimum of 85% accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to:

1. Define terms associated with antilock brake systems by selecting the correct definition from four choices.
2. Match the names of the parts of a four-wheel antilock brake system to an illustration.
3. Match the names of the parts of a rear-wheel antilock brake system to an illustration.
4. Match the names of the components of an antilock brake system to descriptions of their functions.
5. Identify types of four-wheel antilock brake systems from illustrations.
6. Match the names of the parts of an accumulator to an illustration.
7. Identify types of wheel speed sensors from illustrations.
8. Identify differences in servicing and operation between antilock brake systems and regular brake systems.
9. List safety precautions for inspecting, testing, and servicing antilock brake systems.
10. Diagnose pedal feel to determine antilock brake system operation problems. (Assignment Sheet 1)
11. Diagnose antilock brake system hydraulic system problems. (Assignment Sheet 2)
12. Diagnose antilock brake system electronic control system problems. (Assignment Sheet 3)
13. Perform an antilock warning light sequence test. (Job Sheet 1)
14. Discharge integral antilock brake system pressure. (Job Sheet 2)
15. Check and fill an antilock brake system master cylinder and inspect the system for leaks. (Job Sheet 3)
16. Pressure bleed an integral antilock brake system. (Job Sheet 4)
17. Remove, clean, inspect, and replace wheel speed sensors. (Job Sheet 5)

18. Perform a pressure diagnosis on an integral antilock system fluid pressurization system. (Job Sheet 6)

19. Remove and install hydraulic antilock brake system components. (Job Sheet 7)

20. Measure wheel speed sensor air gaps. (Job Sheet 8)

21. Perform an individual wheel speed sensor pin test. (Job Sheet 9)

SUGGESTED ACTIVITIES

SERVICING ANTILOCK BRAKE SYSTEMS IV

PREPARATION

Review unit and plan presentation

- Study the specific objectives to determine the order in which you will present the objectives. Decide whether or not you wish to add additional objectives.
- Review the teaching suggestions given in the Delivery section and plan classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate students with special needs.

Obtain supplemental materials

- Order films, videotapes and other media to supplement instruction of this unit. See ordering information in the Suggested Resources section. Include in your selection media that demonstrates job sheet skills. Videotape your own procedures if you are unable to obtain suitable media.
- Obtain the Competency Profiles for this unit.

  NOTE: Competency Profiles for this book are available from the Curriculum and Instructional Materials Center, Oklahoma State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364; 1-800-522-5810, ext 589 in-state; 1-800-654-4502 out-of-state.

- Note the equipment and material needs for completing the job sheets.

Prepare classroom and shop

- Display safety signs, posters, and charts that show antilock brake systems and component parts as well as troubleshooting and testing flow charts.
- Have magazine articles, specification guides, service manuals, and technical bulletins, mockups and other references about antilock brake systems available for student use.
- Check the tools, equipment, and material needs for completing the job sheets.

Administer pretest

- The Written Test should be given as a pretest so that identified competencies can be accurately measured.
- Use the section in the Upfront, *Using the CIMC Written Tests as Pretest and Posttest to Measure Student Performance Gains* to assist you in assessing student competencies.
- Consider the pretest results as you prepare your presentation for each objective.

DELIVERY

Unit Introduction

- Discuss the introduction to the unit in the Objective Sheet.
- Discuss the unit objective and then the specific objectives.
- Show the video, *How Automotive Brakes Work*, from the video series, *Antilock Brake Systems Explained.*
- Stress the fact that the brake system operates with the ordinary components an dstandard operation of any braking system *until* a wheel begins to lock up. Only then does the antilock sytem begin operation.
- Discuss shop safety and safety concerns when working with high pressures.

Objective 1: Define terms associated with antilock brake systems by selecting the correct definitions from four choices.

- Show examples or demonstrate terms where applicable.

Objective 2: Match the names of the parts of a four-wheel antilock brake system to an illustration.

- Show the video, *Theory and Operation*, from the video series, *Antilock Brake Systems Explained.*
- Go to the shop and point out the components on an actual vehicle.
- Use Transparency Master 1 to help you discuss the material in the box, *Antilock Brake Operation.*
- Pass around some of the components used in the system. Let the class attempt to identify each component and its location on a vehicle.

Objective 3: Match the names of the parts of a rear-wheel antilock brake system to an illustration.

- Go to the shop and point out the components on an actual vehicle.

- Use Transparency Master 2 to help you discuss the material in the box, *Rear-Wheel ABS.*

- Show the transparencies from *RWAL Update 4WAL Preview Slide Set.*

- Pass around components used in this system. Let the class attempt to identify each component and its location on the vehicle.

- Discuss the fact that rear-wheel ABS are low pressure systems while four-wheel ABS are high pressure systems. Point out how this difference translates into different components, servicing, and safety procedures between low pressure and high pressure systems.

- Discuss the two main rear-wheel ABS, the Kelsey-Hayes system and General Motors' RWAL. Point out their differences and similarities.

Objective 4: Match the names of the components of an antilock brake system to descriptions of their functions.

- Discuss the function of each component, using the notes and boxed material on *ABS Controllers and Solenoid Valve Body Operation* to help you.

- Point out the combined units found in hydraulic units and modulators.

- Quiz the students over which components will most likely be found on four-wheel ABS, and which on rear-wheel ABS.

- Use actual components to help you explain the special designs, components, and functions necessary in high pressure antilock brake systems.

Objective 5: Identify types of four-wheel antilock brake systems from illustrations.

- Show the video, *Anti-Lock Brake System.*

- Use Transparency Masters 3-7 to help you discuss how to identify different types of antilock brake systems.

- Show the students different ABS on as many actual vehicles as possible.

- Explain that the examples and illustrations shown in this curriculum are but a few of the different types of systems available.

- Stress that the seemingly small differences between each system translate into important differences in diagnosis, testing, and servicing. It is critical that the service manual for the system be used.

- Have individual students or groups of students research antilock systems not mentioned in this curriculum and report their findings to the class.

Objective 6: Match the names of the parts of an accumulator to an illustration.

- Show a cutaway or a transparency of the inside of an accumulator.

- Use Transparency Master 8 and the boxed material, *Accumulator Operation*, to help you discuss the function and operation of an accumulator.

- Allow the students to handle one or more actual accumulators. Try to get several different kinds.

Objective 7: Identify types of wheel speed sensors from illustrations.

- Pass around several different types of wheel sensors from four wheel ABS and RWAL. Explain how they are mounted and how they function.

- Use Transparency Masters 9 and 10 and the boxed material, *Wheel Speed Sensor Operation*, to help you explain how wheel speed sensors work.

- Construct a demonstration model with a wheel speed sensor on which the student can crank a wheel mounted with a wheel speed sensor and the resulting electricity will light a small flashlight bulb. Allow the students to crank the wheel, noting that the faster the wheel is cranked, the brighter the bulb becomes. Explain how this is the same type of electrical signal that alerts the controller the wheel is about to lock up.

Objective 8: Identify differences in servicing and operation between antilock brake systems and regular brake systems.

- Expand the list by writing additional differences in servicing on the chalkboard.

- Discuss the material in the box, *Traction Control Systems*, and give extra credit to students who can find out what vehicles are currently using such a system.

Objective 9: List safety precautions for inspecting, testing, and servicing antilock brake systems.

- Demonstrate the proper precautions for each item listed.

APPLICATION

DIAGNOSIS SKILLS

Diagnosis is the highest level of competence in automotive service. Any type of automotive diagnosis requires that the technician possess both extensive knowledge and considerable practical skill. In this series, the Assignment Sheets are designed to help the student learn the diagnostic skills involved in using troubleshooting procedures and diagnostic charts commonly found in vehicle service manuals. These skills are only part of the total requirement for diagnostic excellence.

We recognize that a good diagnosis cannot be made without the practical knowledge the student will learn from performing the Job Sheet tasks. At the same time, the Job Sheet procedures should not be performed unless the necessity for them is indicated by a proper diagnosis. You will need to analyze your teaching techniques and decide whether to have your students do the Assignment Sheets before the Job Sheets or vice versa. For students who are newly learning these skills, there are pitfalls to both sequences.

Objective 10: Diagnose pedal feel to determine antilock brake system operation problems. (Assignment Sheet 1)

- Review the information found in the Assignment Sheet and Supplements used in completing the Assignment Sheet.

- Use the Supplements provided to develop additional questions for student practice.

- Have the students complete Assignment Sheet 1.

Objective 11: Diagnose antilock brake system hydraulic system problems. (Assignment Sheet 2)

- Show the video, *Service and Troubleshooting*, from the video series, *Antilock Brake Systems Explained.*

- Show the video, *Delco Moraine ABS III.*

- Explain to the students that each antilock brake system has its own unique series of troubleshooting methods, tests, and diagnostic charts. Although the charts given in support of this Assignment Sheet are typical, they represent only part of the tests and charts for one antilock system. The Assignment Sheets are designed to give the student some limited experience with this type of diagnosis. More comprehensive experience can be gained from following all the steps and charts designed for an antilock system found in your shop.

- Discuss the use of specialized tools for antilock brake service and the ways technicians can find information about such tools. The pressure gauge "J-35604-88" referenced in Supplement 5 is a gauge used to measure up to 3500 lbs. of pressure.

- Use the Supplements provided to develop additional questions for student practice.

- Have the students complete Assignment Sheet 2.

Objective 12: Diagnose antilock brake system electronic control system problems. (Assignment Sheet 3)

- Review the students on electrical principles using materials from unit C-1 in *Introduction to Automotive Service*

- Show the students ABS diagnostic charts and tests from the service manual of an ABS other than the Teves ABS.

- Use the materials to develop additional questions for student practice.

- Have the students complete Assignment Sheet 3.

Objective 13: Perform an antilock warning light sequence test. (Job Sheet 1)

- Show the students where to locate the parking brake switch, pressure differential switch, brake light, and antilock warning light on the vehicle(s) with ABS you have in your shop.

- Use the service manual for your ABS vehicle to show the students how to use the antilock warning light sequence test to help them diagnose antilock problems.

- Have the students complete Job Sheet 1.

Objective 14: Discharge integral antilock brake system pressure. (Job Sheet 2)

- Explain that the ABS system is pressurized *electrically* and that every time the key is turned ON the ABS pump pressurizes the system. Contrast this with the vacuum-powered regular brake system.

- Impress upon students that they must pump the brake pedal with the key OFF for at least 15 to 20 times or until the pedal gets hard. If the key is on, the pump will recharge the system automatically.

- Review the safety procedures for servicing antilock systems with high pressurize fluids.

- Have the students complete Job Sheet 2.

Objective 15: Check and fill an antilock brake system master cylinder and inspect the system for leaks. (Job Sheet 3)

- Show the students the markings on the reservoir of the vehicle(s) you will be using in your shop.

- Have the students locate the recommended brake fluid replacement schedule for the ABS vehicle in your shop.

- Discuss the differences in brake fluid and why most manufacturers warn against using D.O.T. 5 (synthetic) fluid.

- Explain why the accumulator must be discharged before checking and filling the reservoir.

- Demonstrate how to inspect for leaks.

- Have the students complete Job Sheet 3.

Objective 16: Pressure bleed an integral antilock brake system. (Job Sheet 4)

- Demonstrate to the students how a pressure brake bleeder is used.

- Explain why manual bleeding procedures are not recommended for bleeding antilock brake systems.

- Have the students complete Job Sheet 4.

Objective 17: Remove, clean, inspect, and replace wheel speed sensors. (Job Sheet 5)

- Discuss with the students how the sensor cable is constructed and why it is made in that fashion.

- Discuss the importance of following the manufacturers' instructions for removal, cleaning and inspecting wheel speed sensors.

- Have the students complete Job Sheet 5.

Objective 18: Perform a pressure diagnosis on an integral antilock system fluid pressurization system. (Job Sheet 6)

- Demonstrate the proper attachment procedures for a pressure gauge.

- Use the service manual for the ABS vehicle in your shop to show the students the recommended procedure for this job sheet.

- Have the students complete Job Sheet 6.

Objective 19: Remove and install hydraulic antilock brake system components. (Job Sheet 7)

- Remind the students that all components are not replaceable and that they should check the service manual for information on those components that are.

- Review safety precautions for antilock component replacement.

- Use the service manual for the ABS vehicle in your shop to show the students the recommended procedure for this job sheet.

- Have the students complete Job Sheet 7.

Objective 20: Measure wheel speed sensor air gaps. (Job Sheet 8)

- Show the student the section of the service manual that discusses speed sensor air gaps.

- Remind the students that not all sensors have adjustable air gaps and that they must use a nonmagnetic feeler gauge when checking gaps.

- Use the service manual for the ABS vehicle in your shop to show the students the recommended procedure for this job sheet.

- Have the students complete Job Sheet 8.

Objective 21: Perform an individual wheel speed sensor pin test. (Job Sheet 9)

- Make sure the students know how to use a digital multimeter. Use the material in *Introduction to Automotive Service* to help review them if necessary.

- Remind the student that analog multimeters can damage the controller and therefore should not be used.

- Use the service manual for the ABS vehicle in your shop to show the students the recommended procedure for this job sheet.

- Have the students complete Job Sheet 9.

EVALUATION

- Give the written test.

  NOTE: The written test may be given in sections if desired.

- Many multiple-choice test questions (in the Activity Sheets, Assignment Sheets, and Written Test) for this curriculum have been written in a style that is similar to the questions on the ASE certification test. Like ASE questions, the student should select the item that **BEST** answers the question. *The student should make no additional assumptions about a question other than those specifically given in the question.* A special effort has been made to provide good distracters for each question which will make the student think through the answer. It is suggested that the instructor review the answers to every test before reviewing the test with the students so that he or she is not caught off guard by such distracters.

- Evaluate the class on the Assignment Sheet activities if not previously done.

- Give the Practical Tests. Evaluate the tests on the forms provided.

- Reteach and retest as required.

- The Activity Sheet may be given at the end of the unit as a review and a preview of the ASE test style.

- Complete the appropriate section of the Competency Profiles.

- Review individual and group performance in order to evaluate teaching methods.

- Adjust the scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Resources used in developing unit

- Birch, Thomas W. *Automotive Braking Systems.* Orlando Florida: Harcourt Brace Jovanovich, Publishers, 1988.
- *Bosch ABS 2U and 2S "Micro" Antilock Brake Systems.* Detroit, Michigan: General Motors Corp., 1990.
- Brake Systems Parts Manufacturers Council. *Automotive Brake Systems.* Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1991.
- *Corvette Antilock Brakes.* Detroit, Michigan: General Motors Corp., 1986.
- *Delco Moraine Antilock Brake System III.* Detroit, Michigan: General Motors Corp., 1988.
- Hughes, James G. *Brakes.* Orlando, Florida: Harcourt Brace Jovanovich, Publishers, 1987.
- *1989 Rear-Wheel Anti-lock (RWAL) Brake System.* Detroit, Michigan: General Motors Corp., 1989.
- *1990 Truck Shop Manual.* Detroit, Michigan: Ford Service Publications, 1989.
- Scharff, Robert. *Complete Brake Systems.* Albany, New York: Delmar Publishers, 1989.
- *Teves Antilock Brake System (ABS).* Detroit, Michigan: General Motors Corp., 1989.
- *Teves Mark II Antilock Brake System (ABS).* Detroit, Michigan: General Motors Corp., 1991.

Media

Spelling and definitions of terminology used in automotive service are not standardized. Media selected to supplement and reinforce materials taught in this book may or may not use the same spelling and definitions. Although such deviations should not restrict classroom use of supplemental materials, its existence may confuse some students.

- *Bergwall Productions*, Inc. P.O. Box 238, Garden City, New York 11530-0238, phone 1-800-645-3565.

  Antilock Brake Systems Explained. 5 videos.

  How Automotive Brakes Work. Explains different braking systems, describes Teves-Bosch antilock brake systems, covers drum-disk brakes, details fluid circuits. (15 minutes)

  Service & Troubleshooting. Describes the essential tools-equipment-manuals needed for properly servicing an ABS. Describes step-by-step troubleshooting techniques. Safety procedures stressed throughout. (13 minutes)

  Theory and Operation. Introduces operation of ABS, describes advantages over typical hydraulic brake system, introduces use of computer in brake system, details the various components of an ABS including electronic controller, wheel sensors, relays, solenoid valve, accumulator, electric pumps. (16 minutes)

- *Ford Service Publications*, P.O. Box 07150, Detroit, MI 48207, phone 1-800-782-4356.

  Anti-Lock Brake System. Covers basic operation of the four-wheel antilock brake system; describes the components of 3 current systems; includes procedures for diagnosis, testing, adjustment, and service. (21 minutes, VHS)

- *Kent-Moore Tool & Equipment Division*, SPX Corp., 28635 Mound Road, Warren, MI 48092-9923, phone 1-800-468-6657.

  Delco Moraine ABS III. Provides a thorough overview of the system operations of the Delco Moraine Anti-lock Brake System. Explains how to diagnose the system, including manual and pressure bleed procedures and diagnosis using the Tech I. (2 videos, 90 minutes)

  RWAL Update 4WAL Preview Slide Set. Overhead transparencies to be used as classroom support with *RWAL Update 4WAL Preview Instructors Guide* also available. (Transparencies)

ANTILOCK WORDSEARCH PUZZLE

The names of the following automotive antilock terms are located in the following box. Terms are placed horizontally, vertically, and diagonally. See how many you can find.

ACCUMULATOR
COMPUTER
CONTROLLER
DIAGNOSTIC
HYDRAULIC
INSTRUMENTS
LOCKUP
MAGNETIC
MODULATOR
PUMP
SENSOR
SOLENOID
VALVE BODY

S	C	S	T	N	E	M	U	R	T	S	N	I	D	M	Z	X	A	Q	Z
T	H	T	O	J	W	L	H	D	G	M	L	E	A	I	J	P	F	O	V
C	N	K	K	L	X	Q	P	X	R	Z	O	G	G	T	T	C	P	A	R
E	O	P	N	P	E	T	W	O	R	R	N	F	D	M	Z	Y	L	L	Z
F	M	N	T	L	G	N	S	C	O	E	A	I	U	K	W	V	U	J	W
F	C	Q	T	B	R	N	O	T	T	G	L	D	P	L	E	Z	O	I	B
E	U	I	U	R	E	H	A	I	S	M	O	D	P	B	A	P	A	P	W
L	I	A	L	S	O	L	C	O	D	W	Y	L	O	O	W	T	R	T	N
L	D	I	K	U	U	L	A	P	N	P	A	D	E	V	E	E	O	G	L
A	L	R	E	M	A	S	L	P	U	M	Y	O	T	U	T	S	E	R	O
H	K	U	U	E	R	R	M	E	Q	M	B	S	S	U	M	Z	B	S	C
K	M	C	R	Y	Z	I	D	V	R	B	P	S	P	K	X	Y	Y	H	K
W	C	S	G	H	X	I	C	Y	Z	Z	I	M	B	F	N	J	S	W	U
A	B	U	L	E	V	Q	N	H	H	Y	O	J	T	T	V	D	M	B	P
D	I	A	G	N	O	S	T	I	C	C	T	I	Z	G	X	Z	I	X	J

May be photocopied for student use.

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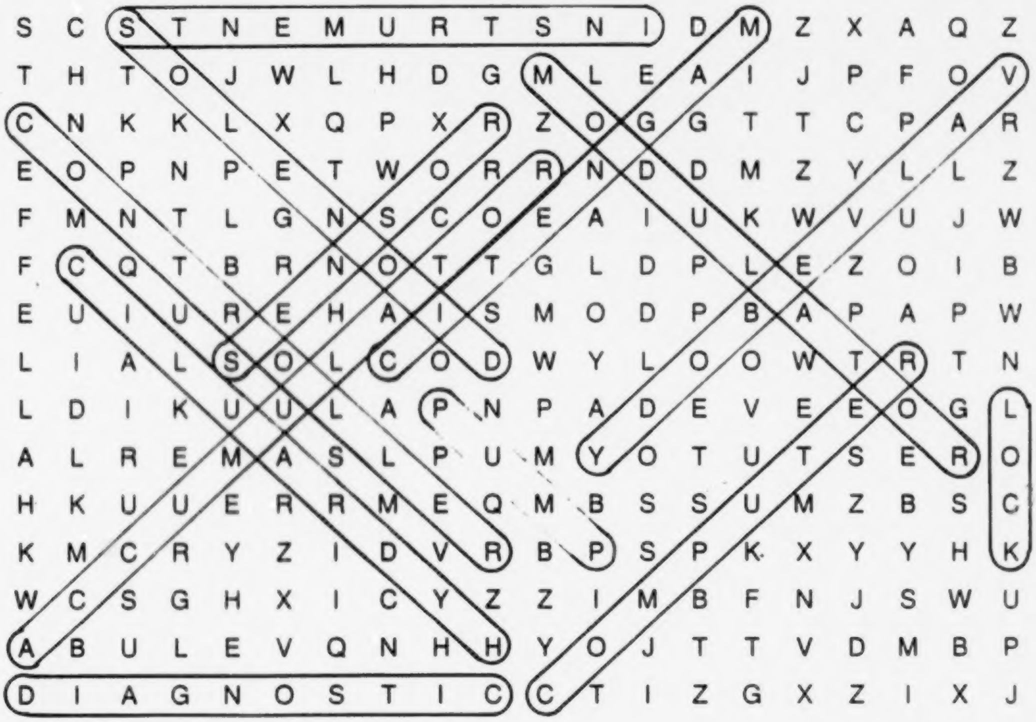
ANSWER TO WORDSEARCH PUZZLE



S	C	S	T	N	E	M	U	R	T	S	N	I	D	M	Z	X	A	Q	Z
T	H	T	O	J	W	L	H	D	G	M	L	E	A	I	J	P	F	O	V
C	N	K	K	L	X	Q	P	X	R	Z	O	G	G	T	T	C	P	A	R
E	O	P	N	P	E	T	W	O	R	R	N	D	D	M	Z	Y	L	L	Z
F	M	N	T	L	G	N	S	C	O	E	A	I	U	K	W	V	U	J	W
F	C	Q	T	B	R	N	O	T	T	G	L	D	P	L	E	Z	O	I	B
E	U	I	U	R	E	H	A	I	S	M	O	D	P	B	A	P	A	P	W
L	I	A	L	S	O	L	C	O	D	W	Y	L	O	O	W	T	R	T	N
L	D	I	K	U	U	L	A	P	N	P	A	D	E	V	E	E	O	G	L
A	L	R	E	M	A	S	L	P	U	M	Y	O	T	U	T	S	E	R	O
H	K	U	U	E	R	R	M	E	Q	M	B	S	S	U	M	Z	B	S	C
K	M	C	R	Y	Z	I	D	V	R	B	P	S	P	K	X	Y	Y	H	K
W	C	S	G	H	X	I	C	Y	Z	Z	I	M	B	F	N	J	S	W	U
A	B	U	L	E	V	Q	N	H	H	Y	O	J	T	T	V	D	M	B	P
D	I	A	G	N	O	S	T	I	C	C	T	I	Z	G	X	Z	I	X	J

SERVICING ANTILOCK BRAKE SYSTEMS

OBJECTIVE 1

Define terms associated with antilock brake systems by selecting the correct definition from four choices.

ABS (antilock brake system) – a brake system designed to prevent skidding when the brakes are applied on slick or loose surfaces

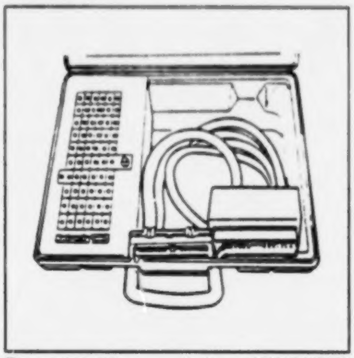
NOTE: ABS are also known as *skid control systems (SCS).*

breakout box – a specialized piece of ABS testing equipment that allows the voltage and/or continuity to be tested without probing the wiring of the antilock system (FIGURE 1)

NOTE: The controllers on most systems have a hookup to allow a breakout box to be installed.

EXAMPLE:

FIGURE 1



Reproduced by permission. COMPLETE BRAKE SYSTEMS, by Robert Scharff, Delmar Publishers, Inc., Copyright 1989.

driveshaft – the part of the driveline that transfers the engine's turning power from the transmission to the differential

drive pinion gear – the gear in the differential that transfers the engine's turning power from the driveline to the differential

integrate – to combine several independent components into a single unit

lockup – the point when a vehicle's tires have stopped rotating, even though the momentum of the vehicle keeps the vehicle moving

probe – to insert the metal tip of a test instrument into the wiring of an electrical circuit in order to test it

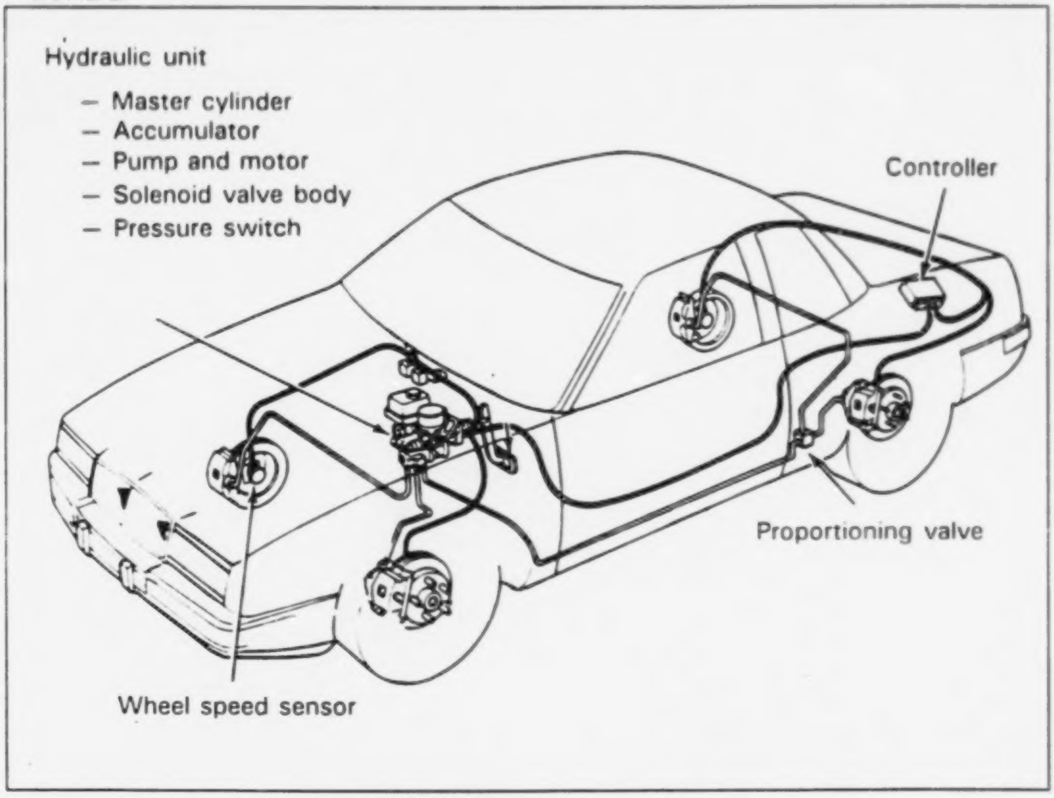
skid – the action that occurs when a vehicle's momentum keeps the vehicle moving even though its wheels are not turning

NOTE: When wheels *lock up*, the vehicle *skids*, causing the driver to lose control of the vehicle. A vehicle that is skidding takes longer to stop. Skidding also causes flat wear spots on the tires where a single surface of the tire has dragged on the road.

solenoid – an electromagnetic control device which is commonly used to open or close an electrical circuit

OBJECTIVE 2 **Match the names of the parts of a four-wheel antilock brake system to an illustration.**

FIGURE 2


Hydraulic unit
– Master cylinder
– Accumulator
– Pump and motor
– Solenoid valve body
– Pressure switch
Controller
Proportioning valve
Wheel speed sensor

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NOTE: Most antilock systems are four-wheel systems. In the Teves antilock system above, the pump, accumulator, solenoid valve body, pressure switch, and master brake cylinder are integrated into one hydraulic unit. Most four-wheel antilock brake systems use integrated hydraulic units like this that are designed especially for antilock systems.

ANTILOCK BRAKE OPERATION

In ordinary braking, the brake system is designed to stop the vehicle by stopping the wheels. Ordinarily the wheels do not stop instantly. The vehicle's weight, forward motion, and friction with the road don't allow this to happen. Instead, the wheels are slowed by the friction of the brake discs or drums. This type of action is normal and desirable.

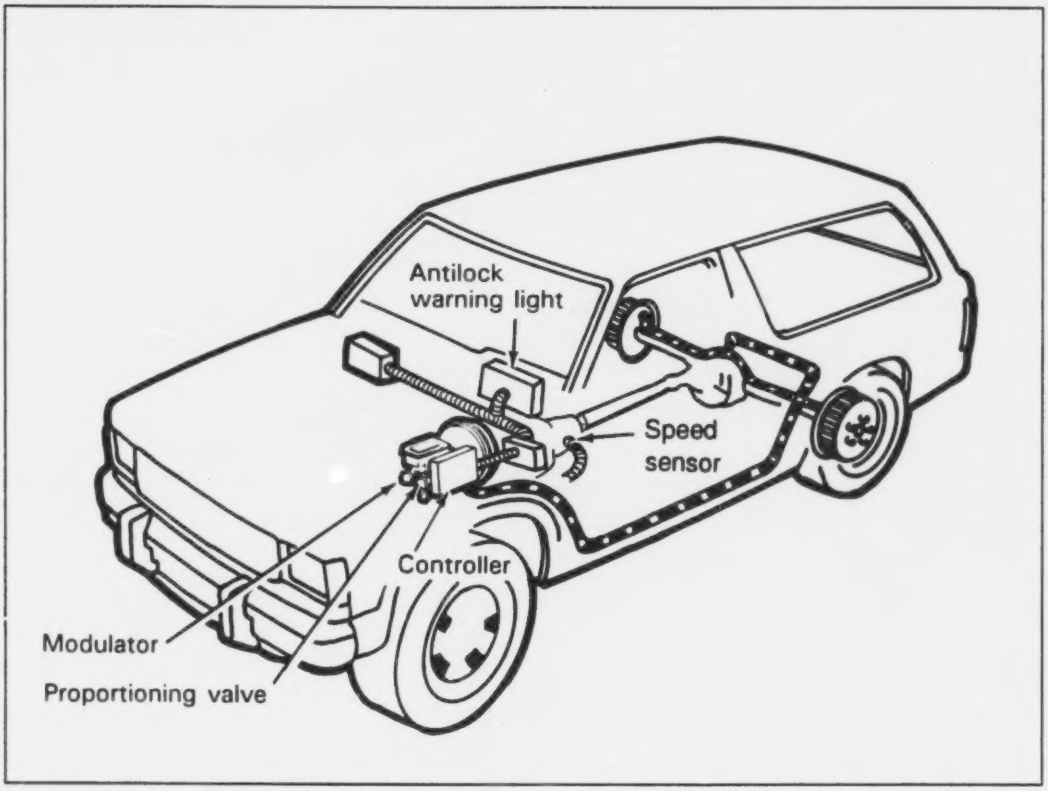
However when the road surface is slick (from rain, ice, or snow) or loose (as on a gravel road), the vehicle will sometimes skid. Skidding is caused when the brakes are applied and one or more wheels instantly stop turning; they ***lock up***. Even though one or more wheels is not turning, the weight and forward motion of the vehicle carry it forward-out of control.

In an antilock brake system, wheel speed sensors monitor wheel speed and notice when one wheel slows down faster than the others–a condition that occurs just before lockup. The wheel sensor transmits this information to a controller which analyzes the information and quickly sends an electronic signal to the solenoid valve body. The solenoids in the solenoid valve body pump the brake in the wheel(s) that are about to lock up and the skid is avoided.

It is important to note that all antilock brake systems operate the same as regular brake systems most of the time. It is only when wheel lockup and skidding is about to occur that the antilock system intervenes in the normal braking process.

OBJECTIVE 3 | **Match the names of the parts of a rear-wheel antilock brake system to an illustration.**

FIGURE 3


Antilock warning light
Speed sensor
Controller
Modulator
Proportioning valve

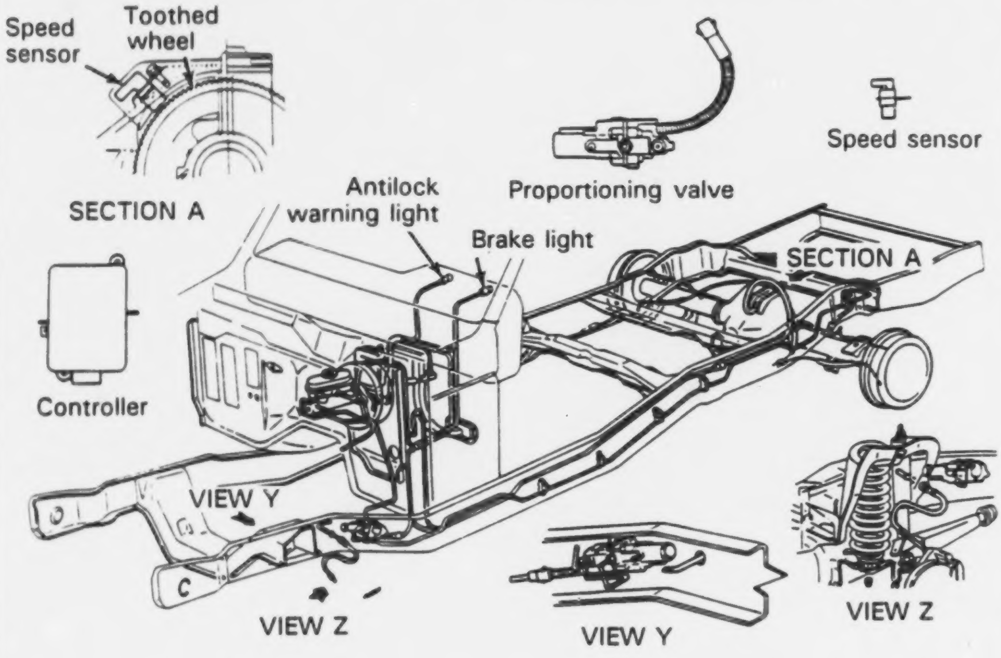
Copyright ©General Motors Corp. Used with permission

REAR-WHEEL ABS

Antilock control on rear-wheel antilock brake systems is found only at the rear wheels. This least complicated of all antilock systems is found only on light trucks. Because they do not use high pressure brake fluid systems, rear-wheel ABS do not have a pump, separate accumulator, or pressure switch.

Wheel speed on rear-wheel ABS systems is sensed at different locations by different system–the wheels, the transmission output shaft, the differential drive pinion gear, or the driveshaft.

Ford's rear-wheel ABS does not use a modulator unit. Instead it has a simpler *electro-hydraulic valve* to perform the modulator function. The modulator may be located in several different places. Some are found at the rear of the vehicle, while others, such as the one shown in the illustration above, are located just below the master cylinder.


Speed sensor
Toothed wheel
SECTION A
Antilock warning light
Proportioning valve
Speed sensor
Brake light
SECTION A
Controller
VIEW Y
VIEW Z
VIEW Y
VIEW Z

Used with permission of Ford Motor Co.

Chrysler's rear-wheel ABS is a ***Kelsey-Hayes*** system. (See illustration above.) Ford calls its ABS ***RABS***, but it is also a Kelsey-Hayes system. General Motor calls its rear-wheel ABS ***RWAL***. (See Figure 3 on the previous page.)

OBJECTIVE 4

Match the names of the components of an antilock brake system to descriptions of their functions.

accumulator – stores high pressure brake fluid during antilock operation

NOTE: Accumulators (as a separate unit) are only used on antilock systems that operate under high pressure. In most four-wheel antilock systems the accumulator, solenoid valve body, pressure switch, pump and motor, and master cylinder are combined into a single integral hydraulic unit. In rear-wheel ABS, a solenoid valve body and a small accumulator are combined in one housing and are called a *modulator*.

antilock warning light – signals the driver that the antilock system is not working

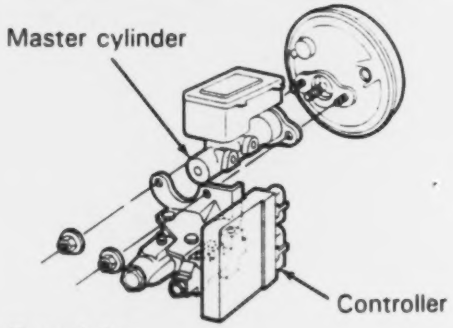
NOTE: Even though the antilock system is not working, the braking system will still work as an ordinary brake system. There may be many reasons why the antilock system is not working; the antilock warning light will not tell you why, only that the system is not operating. Located on the driver's instrument panel, this light is frequently used to assist the technician in diagnosing antilock problems.

controller – receives information from the wheel speed sensors, analyzes it, and sends a signal to the solenoid valve body to pump the brakes

ABS CONTROLLERS

A controller is a computer unit. When the wheel speed sensors send signals that indicate that wheel lockup is about to occur, the controller organizes its signals to the solenoid valve body so that the solenoids pump the brakes to prevent skidding.

Most ABS controllers have self-diagnostic and self-test abilities. When the vehicle is started the controller will analyze the system, close it down, and flash the antilock warning light if there is any problem.



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Controllers come in various sizes and shapes and are located in widely varying parts of the vehicle. On many four-wheel antilock systems, the controller is found in the trunk area. Others are found under the driver's seat, between the door and the firewall on the passenger side, or attached to the master cylinder.

hydraulic unit – an integral unit usually consisting of a master cylinder, accumulator, pressure switch, pump and motor, and solenoid valve body

NOTE: Hydraulic units are usually found on four-wheel antilock systems.

modulator – contains a solenoid valve body and a small accumulator, combining the functions of both

NOTE: Modulators are usually found only on rear-wheel and low pressure antilock brake systems.

pressure switch – monitors the hydraulic pressure level of the brake system and turns the pump on and off to maintain the correct pressure

proportioning valve – delays hydraulic pressure to the rear wheels so they don't brake before the front wheels

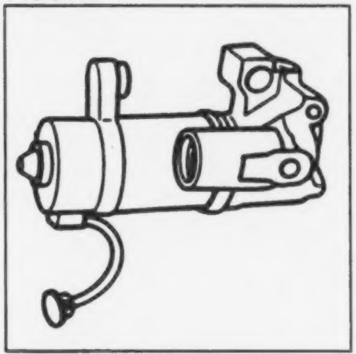
NOTE: This delay helps prevent the vehicle from skidding. The proportioning valve serves the same purpose in an antilock system that it does in an ordinary brake system. Not all ABS have proportioning valves.

pump and motor – pressurizes the brake fluid used in the antilock brake system (FIGURE 4)

NOTE: Because antilock brakes must respond more quickly and often more frequently than an ordinary brake system, the brake fluid must be under a higher pressure to meet these demands. The pump and motor on an ABS can provide up to 3300 psi pressure compared to about 1000 psi in an ordinary system. Pump action is controlled by a pressure switch within the system and has a relief valve to prevent over-pressurizing the system. Not all antilock brake systems operate at high pressure. Rear-wheel and some four-wheel antilock systems operate at the same pressure as ordinary brake systems.

EXAMPLE:

FIGURE 4



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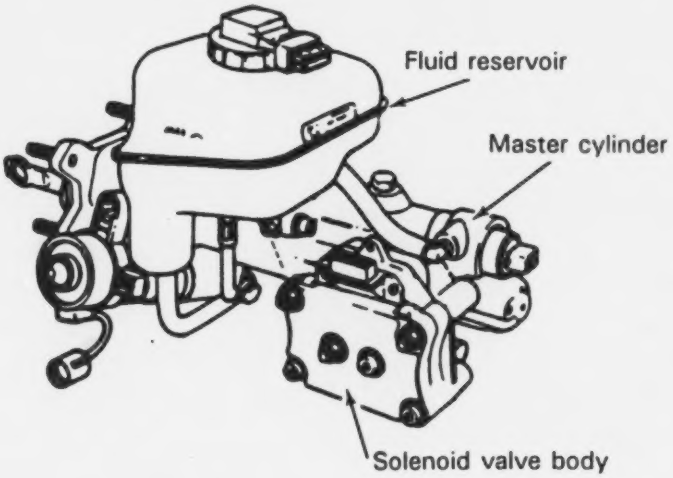
solenoid valve body – when they receive the appropriate signals from the controller, solenoids in this component pump the brakes to the appropriate wheels to prevent lockup

SOLENOID VALVE BODY OPERATION



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The solenoid valve body contains valves (controlled by solenoids) that open or close to allow pressurized brake fluid to operate the wheel cylinders. During braking, when the controller senses that a wheel is moving slower than vehicle speed, it will signal the solenoid to close the valve and stop the flow of pressurized brake fluid to the affected wheel cylinder, allowing the wheel to increase speed.

At the same time the valve closes from the master cylinder, a valve opens between the wheel cylinder and the accumulator; the brake fluid that was present in the wheel cylinder flows into the accumulator. As the wheel again begins to turn, the controller will signal the solenoid to release pressurized brake fluid from the accumulator to the wheel cylinder–causing the wheel to slow down. These actions occur in rapid sequence, effectively pumping the brakes controlling the wheel about to lock up.

Meanwhile the other solenoids will hold pressure on the other wheels unless they also begin to turn too slowly, at which time the same sequence will begin with them. The solenoids are capable of pumping the brakes up to 15 times per second. Human operators can only pump the brakes about 3 to 4 times per second.

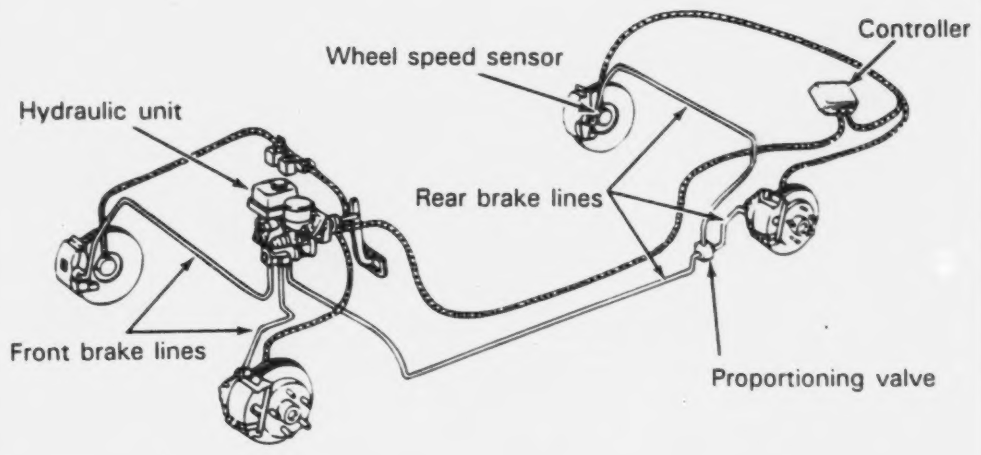
wheel speed sensor — monitors individual wheel speed and sends this information to the controller

NOTE: Wheel speed sensors are small AC voltage generators. They generate an electrical current that the controller compares to the current being received from the other wheels. By comparing voltage from all the wheel speed sensors, the controller can determine if lockup is about to occur in any wheel.

OBJECTIVE 5 **Identify types of four-wheel antilock brake systems from illustrations.**

- **Teves ABS**

FIGURE 5


Controller
Wheel speed sensor
Hydraulic unit
Rear brake lines
Front brake lines
Proportioning valve

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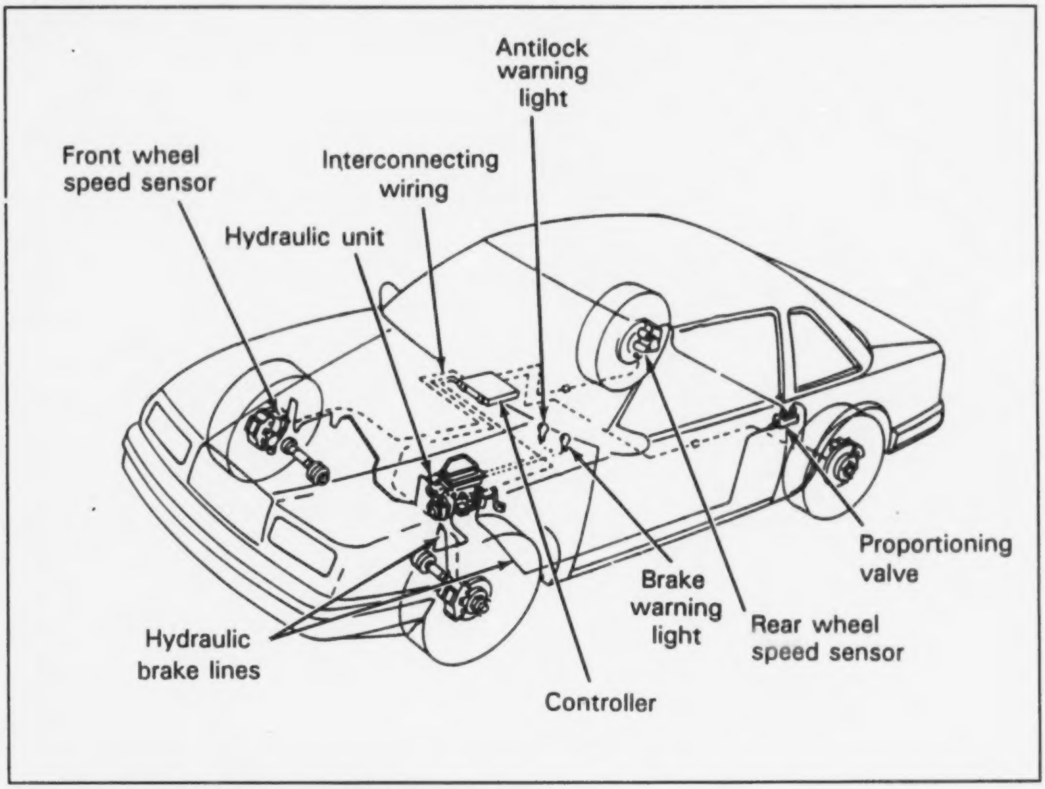
NOTE: The ***Teves*** system is the most commonly used antilock brake system. It is found on many imports and is used by domestic manufacturers such as Ford and General Motors. The special hydraulic unit on this four-wheel antilock brake system houses the master cylinder, accumulator, solenoid valve body, and pump. This is a very high pressure system that must be handled properly to avoid damage to the vehicle or technician.

- **Delco Moraine ABS**

FIGURE 6


Antilock warning light
Front wheel speed sensor
Interconnecting wiring
Hydraulic unit
Proportioning valve
Brake warning light
Rear wheel speed sensor
Hydraulic brake lines
Controller

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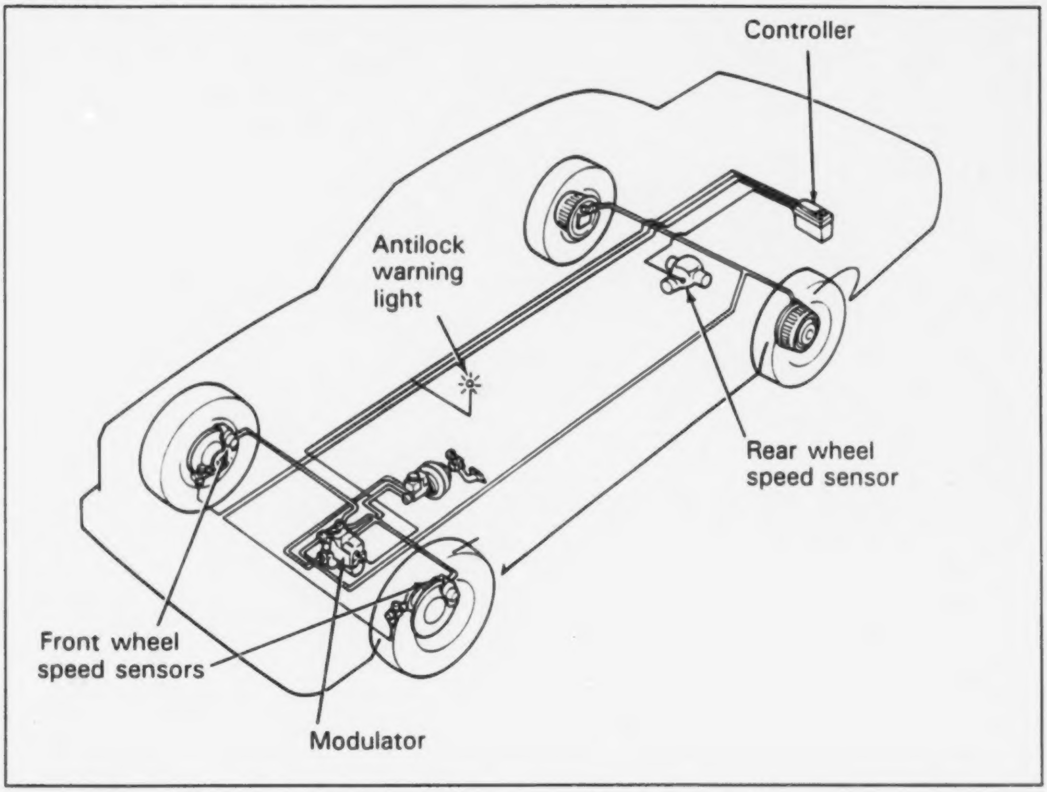
NOTE: The Teves ABS and the ***Delco Moraine*** system are very similar. The design of the master cylinder unit is different in the Delco Moraine system and the controller in the Delco Moraine ABS allows more system tests to be made. All other components are very much alike. General Motors uses both systems.

- **Bosch ABS 2U**

FIGURE 7


Controller
Antilock warning light
Rear wheel speed sensor
Front wheel speed sensors
Modulator

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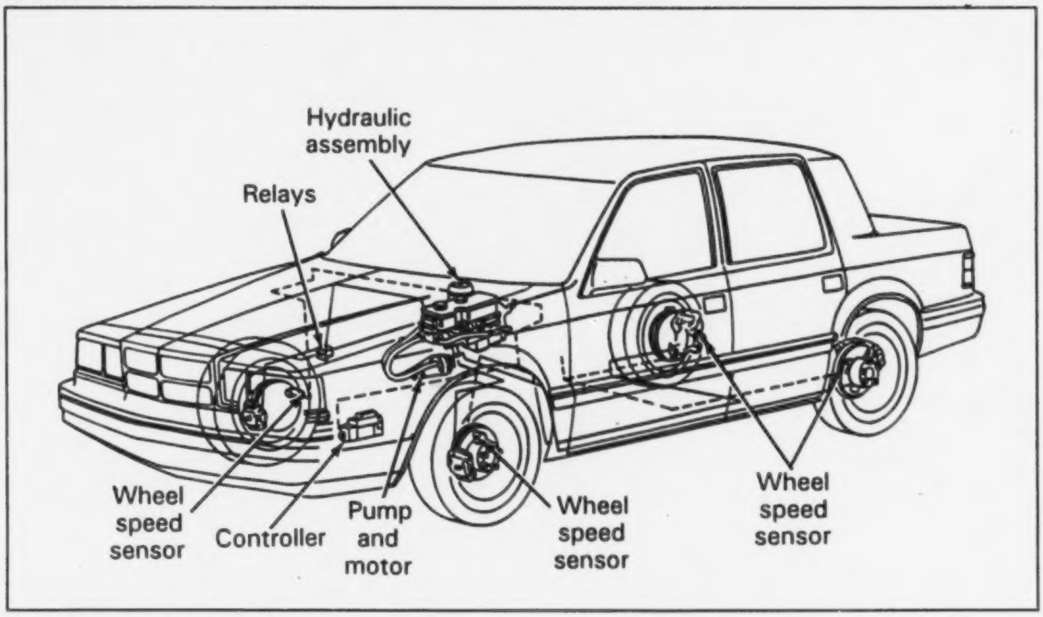
NOTE: The ***Bosch*** ABS is called an add-on system because a modulator is added on to a standard master brake cylinder and vacuum booster. Wheel sensors are located on both front wheels and a single sensor is located on the differential drive pinion gear to monitor the speed of both rear wheels. Bosch systems are found on General Motors and Chrysler vehicles as well as some imports. The Bosch ABS 2U is not a high pressure system and does not have an external accumulator. Some Bosch antilock systems, however, are high pressure systems.

- **Bendix ABS**

FIGURE 8


Hydraulic assembly
Relays
Wheel speed sensor
Controller
Pump and motor
Wheel speed sensor
Wheel speed sensor

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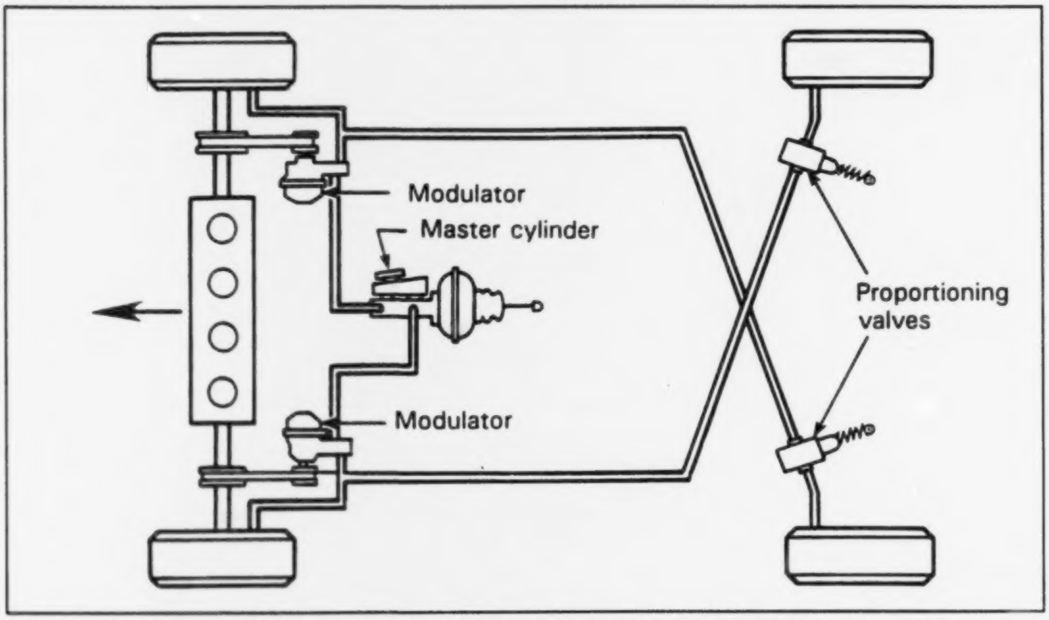
NOTE: The ***Bendix*** ABS is used primarily on Chrysler products. The accumulator is cylindrical and the proportioning valves (one for each rear wheel) are mounted on the master cylinder.

- **Lucas-Girling SCS (Skid Control System)**

FIGURE 9



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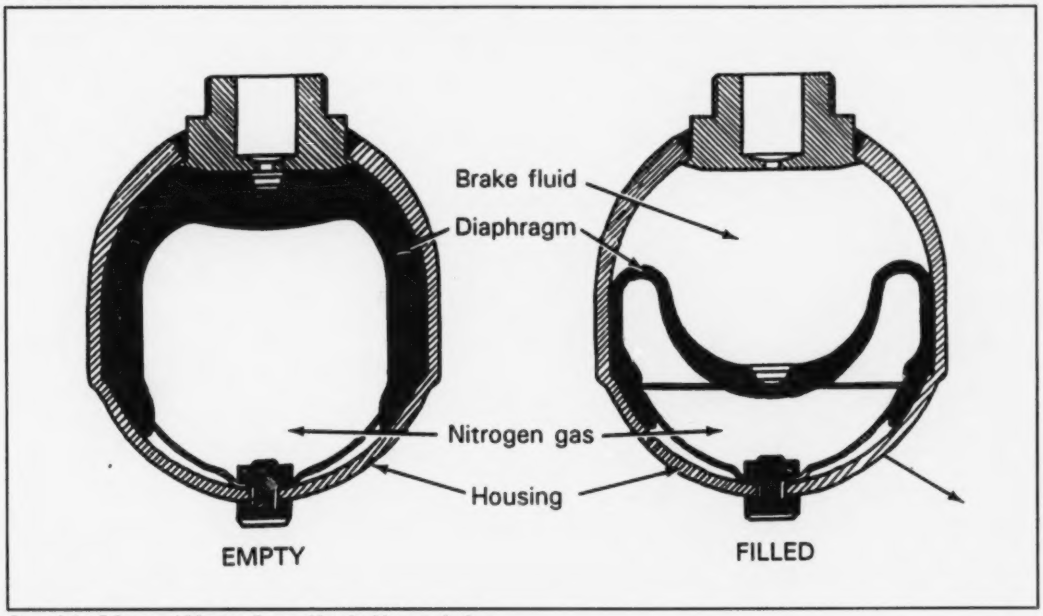
NOTE: The ***Lucas-Girling*** SCS is unique since it is a mechanical rather than a computer-based system. Not very common, the Lucas-Girling system is found only on front-wheel drive vehicles, mainly English and French imports. Its two modulators are driven by belts attached to the front axles. Notice that this is a diagonally split system with two circuits.

LUCAS-GIRLING SCS OPERATION

Lucas-Girling is a hydromechanical stop control system that is considered by many to be a simpler system than the Bosch or Teves ABS. Lucas-Girling does not use a controller (computer) or wheel speed sensors. Instead, it uses two belt-driven modulator units that rely on flywheel momentum and one-way clutches to open and close pressure valves. When the brakes are applied, the flywheel in the modulator continues to turn faster than the wheels, engaging a one-way clutch that forces the flywheel against the pressure relief valve lever, momentarily reducing brake pressure. The flywheel clutch then releases, allowing the internal pump to generate fluid pressure to restore braking. This continues until the vehicle stops. This system is relatively inexpensive and provides excellent antilock operation and quicker stops.

OBJECTIVE 6 | **Match the names of the parts of an accumulator to an illustration.**

FIGURE 10



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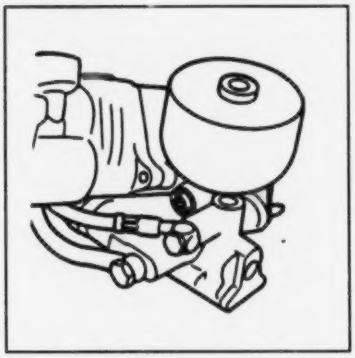
NOTE: The ***accumulator*** is attached to the master brake cylinder and contains enough pressurized brake fluid to apply the antilock brakes 15-20 times. In most high pressure four-wheel antilock brake systems, the accumulator is a separate component which is integrated into the antilock hydraulic unit. In ABS that are not high pressure systems, the accumulator and solenoid valve body are housed in a single unit called a *modulator.*

EXAMPLE:

FIGURE 11



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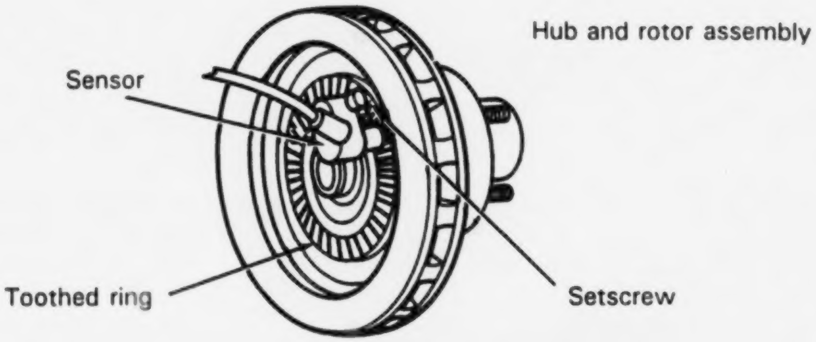
ACCUMULATOR OPERATION

Inside the steel *accumulator housing*, a flexible *diaphragm* separates the *pressurized brake fluid* from *pressurized nitrogen gas* (some accumulators use a spring instead of gas). During antilock operation the solenoid valve body quickly diverts high pressure brake fluid between the accumulator and the wheel cylinder, pumping the brake. The presence of the diphragm and pressurized gas in the accumulator assures that the system does not lose any operating pressure necessary to keep the system working. The accumulator is a sealed canister and is replaced rather than repaired if it fails to work. In rear-wheel ABS systems, the small accumulator built into the modulator is operated by a spring instead of pressurized nitrogen gas.

OBJECTIVE 7 **Identify types of wheel speed sensors from illustrations.**

- **Front Wheel Speed Sensor**

FIGURE 12



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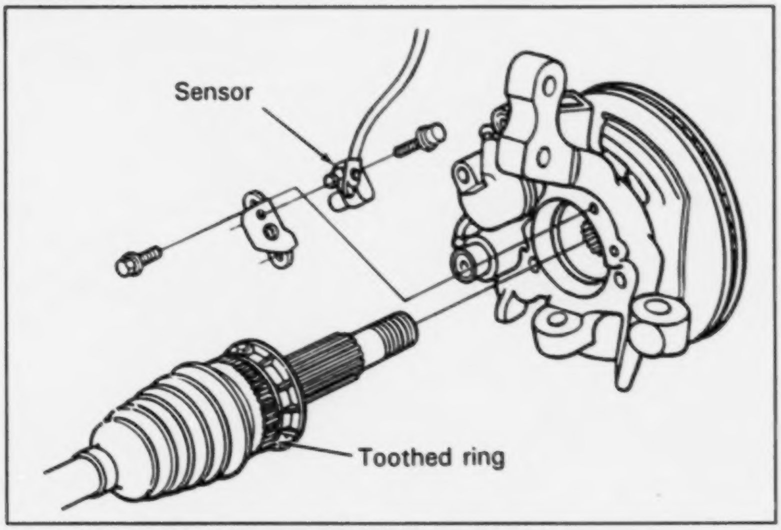
NOTE: Wheel speed sensors are produced in many different designs and vary from vehicle to vehicle. The types shown here are typical.

- **Rear Wheel Speed Sensor – Axle Mounted**

FIGURE 13


Sensor
Toothed ring

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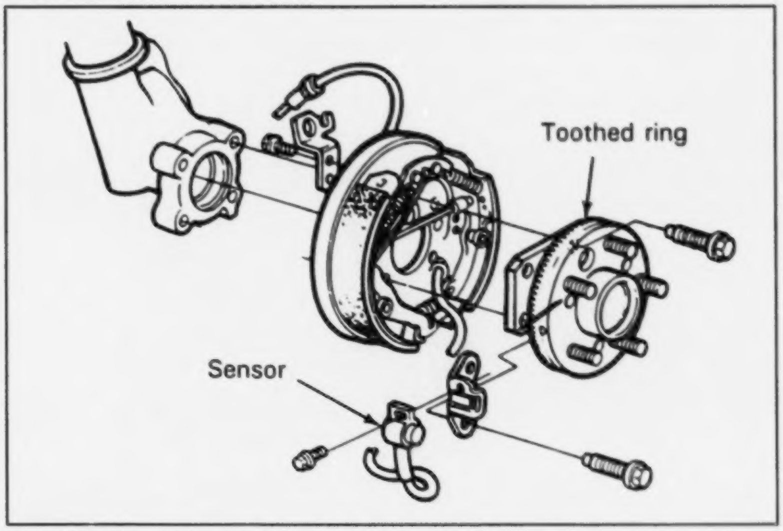
- **Rear Wheel Speed Sensor – Hub Mounted**

FIGURE 14


Toothed ring
Sensor

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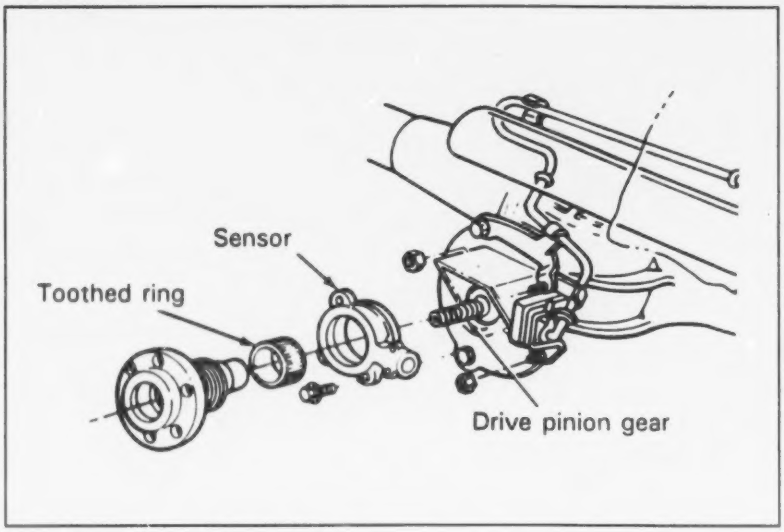
- **Drive Pinion Gear Wheel Speed Sensor**

FIGURE 15



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NOTE: Besides being mounted on the differential drive pinion gear, some wheel speed sensors are mounted on the driveshaft or the transmission output shaft. Sensors mounted on the driveshaft, the differential drive pinion gear, or the transmission output shaft monitor the wheel speed of *both* rear wheels together rather than individually.

WHEEL SPEED SENSOR OPERATION

A wheel speed sensor consists of two magnetic parts: a *toothed ring* and a *sensor*. As the wheel spins, the two components, installed close together, but not touching, act like an A/C generator and create a voltage that varies with wheel speed. When the brakes are applied, the ABS controller compares the electrical signals being received from every sensor. If the signals show that there is too rapid a reduction in voltage from one sensor, the controller is alerted that the wheel being monitored by that sensor is about to lock up. Wheel speed sensors are critical to the operation of the ABS system. Some sensors are adjustable and some are not.

OBJECTIVE 8

Identify differences in servicing and operation between antilock brake systems and regular brake systems.

ANTILOCK BRAKE SYSTEMS	REGULAR BRAKE SYSTEMS
Difference in operation:	
Wheels are pumped and lockup prevented without driver awareness or involvement	Driver must pump brakes manually after lockup occurs to control the vehicle
Differences in servicing:	
Brakes should not be bled manually	Manual brake bleed is acceptable
Brake fluid must be flushed and replaced often	Frequent flushing or brake fluid replacement not required
Most parts are not serviceable	Most parts are serviceable
There are many components and they are expensive	There are fewer, more inexpensive components
Master cylinders are designed to withstand high pressure and cannot be rebuilt	Most master cylinders can be rebuilt
The high pressure used requires special safety precautions during servicing	No special high pressure safety precautions are required

TRACTION CONTROL SYSTEMS

In some vehicles with antilock brakes, regular antilock components are being used in a new way–to help traction when driving on slippery roads. Often the vehicle's wheels will lose traction and begin to spin when driving on slick roads. One wheel usually spins faster than the others and the normal operation of the differential allows the wheel with less traction to take most of the power, leaving the opposite wheel no power to pull the vehicle out of the difficulty. Special limited-slip differentials are sometimes used to remedy this problem.

In a ***Traction Control System***, the normal functions of antilock components are used to solve this different set of problems. Instead of detecting a *slowing* wheel, the wheel speed sensors are used to detect a *spinning* wheel. They pass this information along to the antilock controller and the controller applies the brake only to the overspinning wheel, allowing the slower wheel to receive the power to pull the vehicle out of the slippery situation.

Traction Control Systems are presently found in only a tiny number of vehicles, but as production costs lower, more and more vehicles may use antilock brake systems in this new way.

OBJECTIVE 9

List safety precautions of inspecting, testing, and servicing antilock brake systems.

For Inspecting:

- Do not road test vehicles if the brake warning light is lit.

  NOTE: Repair the brake hydraulic system before driving the vehicle.

- Wear safety glasses when inspecting brake lines and hoses.

  NOTE: Most antilock brake systems are under extremely high pressures. If a brake line is leaking, fluid may exit the hose as a high pressure stream, causing eye damage.

- Do not chafe or abuse wheel sensors or their cables when you inspect brakes.

  NOTE: The cables are specially shielded and will require replacement if damaged. The sensor adjustments are critical to proper operation.

For Testing:

- Use only a digital multimeter for electrical testing.

  NOTE: Analog (dial type) multimeters draw more current than ABS systems can able to handle; their use can damage the controller.

- When you are testing, use only gauges and hoses capable of withstanding several thousand pounds of pressure.

  NOTE: This is necessary because of the high pressure used in most systems.

- Do not probe wiring or harness connections–use a breakout box.

  NOTE: Connectors and wiring are delicate. Any attempts at probing can result in loose or damaged connectors or wiring. Computerized control systems operate on low voltages and low current. Even a slight voltage drop from what the computer expects to see can cause system problems. Poor connection or damaged wiring causes voltage drops.

- Do not activate solenoids for more than 30 seconds.

  NOTE: Solenoids are designed to operate very quickly–they are ordinarily on for only microseconds at a time. Activation during testing procedures should be limited to 30 seconds or less to prevent damage to the solenoid windings.

For Servicing:

- Depressurize the hydraulic accumulator before performing any service operations.

  NOTE: Failure to depressurize the accumulator may result in injury to yourself or others nearby or damage to the vehicle's painted surfaces.

- Use ***only*** D.O.T. 3 brake fluid.

  NOTE: D.O.T. 5 brake fluid may damage the parts of the pump, and it may clog some systems.

- Replace the antilock controller with the proper part.

  NOTE: Controllers look very much alike, but each controller is tailored to its specific vehicle application. Replacing this unit with an improper part–even though it may fit–can cause a change in braking distances. This may result in personal injury or vehicle damage.

- Disconnect the controller before arc welding anywhere on the vehicle body.

  NOTE: When arc welding on the body of the vehicle, it is possible for the high current used in the welding process to enter and destroy the antilock controller. The high current can induce voltages in the harness wiring that could severely damage the computer.

MAKING A DIAGNOSTIC ROAD TEST

In order to diagnose many automotive problems, the technician must road test the vehicle to assist him in his evaluation. A road test is more than just a drive around the block. The technician must drive the vehicle in a way that tests it for the automotive problems he suspects, allowing the road test to provide him with answers. A good road test helps the specialist get the *right* answers.

8 STEPS IN MAKING A DIAGNOSTIC ROAD TEST

1. **LISTEN** The first step in making a good road test is listening to the car's owner. What is he or she telling you about the behavior of the car?

2. **ASK QUESTIONS** After listening carefully, use your knowledge to ask questions that will help you in your diagnosis of the car's problems. What? How often? Under what conditions? Is the behavior constant or occasional? How long has the problem existed?

3. **OBSERVE** Let your observations of the vehicle give you important information that will help you in your analysis. How old is the vehicle? What is the mileage? Does the vehicle appear to have ever been in an accident? Look for obvious clues such as leaks, tire wear, or poor springs.

4. **CONSULT THE SERVICE MANUAL TROUBLESHOOTING GUIDE** Check the troubleshooting guide in the service manual for the problems you suspect *before you take the vehicle on the road*. See what type of tests you should make on the vehicle and what symptoms you will be looking for while you are on the road. Do you need to drive at highway speeds? Will you be testing response during a sudden stop? Should you be listening for a noise? Watching for a certain behavior? Know beforehand what you will need to do and observe.

⚠ **WARNING:** SOME VEHICLES MAY NOT BE SAFE to drive. Ask yourself if the car is safe enough to be road tested. IF THE VEHICLE IS NOT SAFE, USE OTHER METHODS TO CHECK YOUR DIAGNOSIS.

---

5. **MAKE THE ROAD TEST** Drive the vehicle, making the tests *suggested by the service manual. Check the owner's* information by driving it under the conditions at which he/she noticed the problem. What does the "noise" sound like? What is the nature of the "vibration?" Be sure to use all normal safety precautions in driving an unfamiliar vehicle: check fluid levels, brake operation, buckle your seat belt, etc. It's also a good idea to road test vehicles over the same routes in case there is a breakdown.

NOTICE: DRIVING IN ANYTHING BUT A NORMAL MANNER can make problems worse or create new ones. DO NOT DRIVE IN A RECKLESS MANNER.

---

6. **NOTE YOUR RESULTS** If you make a number of checks, you may want to pull over and write down a few notes about the vehicle's performance, or you could do this when you return to the shop.

7. **MAKE A PRELIMINARY DIAGNOSIS** Consider all the information you have gathered and make an initial evaluation of the car's problems.

8. **CHECK YOUR DIAGNOSIS** You will need to check your diagnosis by rechecking the service manual, making a visual examination, or conducting other tests. Always make the simpler, less time-consuming tests first.

   NOTE: Due to legal restrictions and insurance regulations, most students ar not allowed to road test vehicles. Check with your instructor before attempting any road test.

BRAKE PEDAL FEEL

More probable causes are listed first.

CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTION
Low or Spongy	Air in system	Bleed system
	Misadjusted brake shoes	Adjust brakes
	Master cylinder pushrod not engaged properly	Repair pushrod mounting
	Rear drum brakes out of adjustment	Adjust rear drum brakes
Pulsates when on dry pavement	Warped drums or rotors	Resurface drums or rotors
Pulsates when on wet or slippery pavement	Normal Condition	No correction required
Hard (key off)	Accumulator not holding pressure	Test accumulator and replace if defective
Hard (key on)	Pump and/or pump motor not operating	Check pump relay or fuse; check for incorrect use of D.O.T. 5 brake fluid—replace pump and flush system if found
Pedal goes to the floor	Loss of brake fluid from leaks	Repair leaks

TROUBLESHOOTING ANTILOCK PROBLEMS

The following steps outline the basic procedures for troubleshooting antilock problems on most ABS systems.

1. **Remember that any antilock system is a regular system first.** Most problems with antilock brake systems are actually problems with the vehicle's regular brake system. If the vehicle has brake problems, most can be solved by inspections and tests which would be carried out in the same way that regular brake inspections and tests are carried out. Do not assume that a problem is caused by the antilock system until you have made all your tests.

2. **Follow the manufacturer's test procedures.** It is important that you follow exactly the procedures the vehicle manufacturer recommends for troubleshooting antilock systems. The correct tests and sequence for one ABS may give you incorrect results if applied to another ABS. Most manufacturers recommend most of the steps that follow. If the manufacturer's tests do not follow these procedures, *follow the vehicle recommendations.*

3. **Make a visual inspection.** The visual inspection of an antilock brake system is slightly different from checking the regular brake system components.

   Inspecting for hydraulic problems is relatively simple. An ABS master cylinder consists of many sections, most of which are not removable. Pressure tests are the only method of detecting internal leaks. Brake lines and hoses must be inspected thoroughly and carefully. These lines carry higher pressures than are in ordinary braking systems. Any cracks or kinks in the lines are unacceptable. Electrical problems uncovered by a visual inspection include loose connections, blown fuses, and damaged wiring.

   Most vehicle service manuals give detailed instructions for inspecting their antilock system. Supplement 4, *ABS Visual Inspection*, is the chart recommended for the Teves ABS. Its checkpoints are typical of many ABS systems. The service manual is the best source of information for making an accurate visual test.

4. **Make a road test.** To check for most regular brake problems and some ABS problems, a road test is often helpful. A road test can be particularly helpful in locating ABS hydraulic problems. If the pedal falls under light pressure, the problem will more than likely be with the hydraulic system. Other symptoms of hydraulic problems that may be observed during a road test are:

   poor stopping
   pulsation
   noise
   brake lockup
   brake fade
   skidding

   Some tests may be made without using a scan tool, while others may require that a scanner be connected. In these cases, an assistant is necessary to monitor results. Use Supplement 1, *Making a Diagnostic Road Test*, to help you make your road test.

5. **Make a functional check or an antilock warning light sequence test.** Most diagnosis of antilock brake system problems will be through the controller; this is the heart of the system. It electronically controls all antilock functions. The controller has capabilities of self-test and will turn on the antilock warning light if something is wrong. Analyzing the conditions under which this light comes on gives important diagnostic information.

   On vehicles without code diagnostics, an ***antilock warning light sequence test*** is made to help you analyze this information. The vehicle service manual will tell you how to make a antilock warning light sequence test. A procedure for this test is also found in Job Sheet 1. In most cases, the antilock warning light sequence test can be included as part of your road test.

   If the vehicle has code diagnostics, a ***functional check*** is made which combines tests made during an antilock warning light sequence test with tests made using a scanner or a multimeter and breakout box.

6. **Follow diagnostic charts and tests to complete the diagnosis.** Once the functional check or the antilock warning light sequence test has been made, ABS manufacturers provide charts which indicate what further tests need to be made. Follow the steps given on these charts to help you complete your diagnosis.

ABS VISUAL INSPECTION

COMPONENT/PART	INSPECT FOR	CORRECTIVE ACTION
Parking brake	Full release	Operate manual release lever to verify release
	Proper switch function; if necessary, unplug switch connector to verify	Adjust cable or repair release systems as required
	Proper vacuum release system operation	Repair switch as required
Brake fluid reservoir	Low fluid level	Add fluid as required; determine cause of fluid loss and repair
Hydraulic unit	External Leaks	Repair leaks as required
Pump/motor assembly	Proper assembly	Install or position components properly
Fusible links and fuses	Open link or fuses	Inspected for cause of failure; replace; verify operation
Connectors: · Main relay · Pump motor relay · Pressure switch · Pump motor · Main valve · Fluid level sensor · Wheel speed sensors · Controller · Ground wiring	Proper engagement	Properly engage connector
	Loose wires or terminals	Repair as required
	Corroded or broken eyelets	Repair as required

If no problem is noted in the visual inspection, proceed to ABS lamp sequence or functional check.

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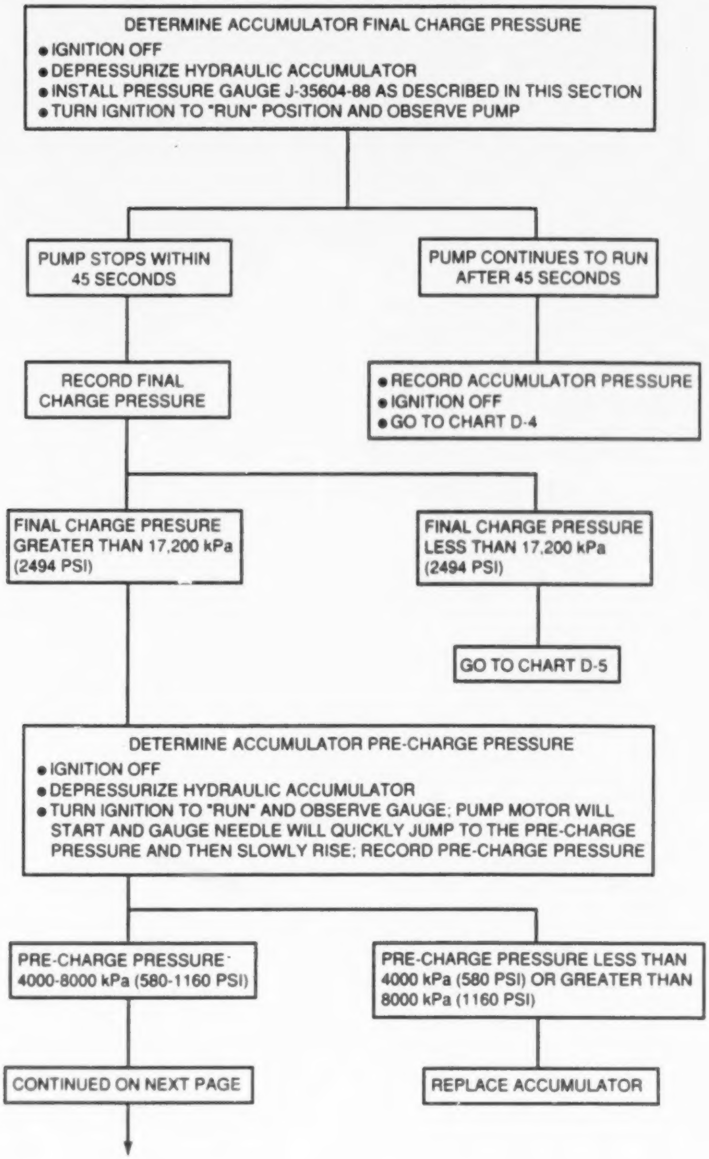
HYDRAULIC UNIT FUNCTIONAL CHECK


DETERMINE ACCUMULATOR FINAL CHARGE PRESSURE
● IGNITION OFF
● DEPRESSURIZE HYDRAULIC ACCUMULATOR
● INSTALL PRESSURE GAUGE J-35604-88 AS DESCRIBED IN THIS SECTION
● TURN IGNITION TO "RUN" POSITION AND OBSERVE PUMP
PUMP STOPS WITHIN 45 SECONDS
PUMP CONTINUES TO RUN AFTER 45 SECONDS
RECORD FINAL CHARGE PRESSURE
● RECORD ACCUMULATOR PRESSURE
● IGNITION OFF
● GO TO CHART D-4
FINAL CHARGE PRESURE GREATER THAN 17,200 kPa (2494 PSI)
FINAL CHARGE PRESSURE LESS THAN 17,200 kPa (2494 PSI)
GO TO CHART D-5
DETERMINE ACCUMULATOR PRE-CHARGE PRESSURE
● IGNITION OFF
● DEPRESSURIZE HYDRAULIC ACCUMULATOR
● TURN IGNITION TO "RUN" AND OBSERVE GAUGE; PUMP MOTOR WILL START AND GAUGE NEEDLE WILL QUICKLY JUMP TO THE PRE-CHARGE PRESSURE AND THEN SLOWLY RISE; RECORD PRE-CHARGE PRESSURE
PRE-CHARGE PRESSURE 4000-8000 kPa (580-1160 PSI)
PRE-CHARGE PRESSURE LESS THAN 4000 kPa (580 PSI) OR GREATER THAN 8000 kPa (1160 PSI)
CONTINUED ON NEXT PAGE
REPLACE ACCUMULATOR

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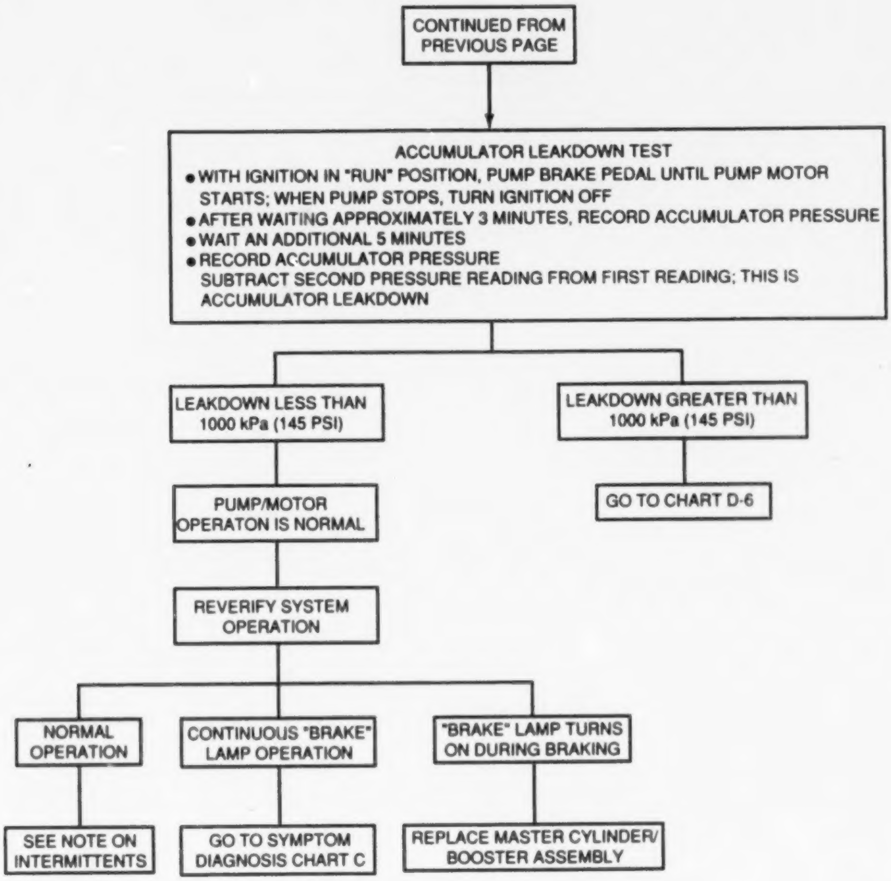
Hydraulic Unit Functional Check (continued)



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ACCUMULATOR LEAKDOWN TEST

- WITH IGNITION IN "RUN" POSITION, PUMP BRAKE PEDAL UNTIL PUMP MOTOR STARTS; WHEN PUMP STOPS, TURN IGNITION OFF
- AFTER WAITING APPROXIMATELY 3 MINUTES, RECORD ACCUMULATOR PRESSURE
- WAIT AN ADDITIONAL 5 MINUTES
- RECORD ACCUMULATOR PRESSURE

SUBTRACT SECOND PRESSURE READING FROM FIRST READING; THIS IS ACCUMULATOR LEAKDOWN

LEAKDOWN LESS THAN 1000 kPa (145 PSI)

PUMP/MOTOR OPERATON IS NORMAL

REVERIFY SYSTEM OPERATION

NORMAL OPERATION

SEE NOTE ON INTERMITTENTS

CONTINUOUS "BRAKE" LAMP OPERATION

GO TO SYMPTOM DIAGNOSIS CHART C

"BRAKE" LAMP TURNS ON DURING BRAKING

REPLACE MASTER CYLINDER/ BOOSTER ASSEMBLY

LEAKDOWN GREATER THAN 1000 kPa (145 PSI)

GO TO CHART D-6

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ABS PROBLEM DIAGNOSIS CHART

More probable causes are listed first.

CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTION
Poor stopping	Loss of pressure to rear wheel cylinders	Repair rear wheel cylinders
	Loss of system pressure	Check components for leaks
	Defective proportioning valve	Replace valve
Skidding	Defective wheel speed sensor	Replace sensor
	Defective proportioning valve	Replace valve
	Blown antilock fuse or diode	Replace antilock fuse or diode
Brake fade	Contaminated brake fluid	Flush system
Clicking or chirping noise during startup	Normal condition at startup	None
Squealing during brake operation	Some is normal	None

TEVES ABS DIAGNOSTIC CHARTS

[The diagnostic materials for the Teves ABS include the following tests and troubleshooting charts. The item is a full-page troubleshooting tree chart unless otherwise indicated. The types of problems diagnosed for each main test or chart (A, B, C, etc.) are indicated by the subtests listed below it. The charts marked with an asterisk (*) are included in this unit.]

	ABS Visual Inspection
	Lamp Sequence Check
	Lamp Sequence Chart*
	ABS Functional Check*
	ABS Code Index*
Test A	Pinout Checks
A-1	ABS Codes 11 and 12
A-2	Main Valve – ABS Code 21
A-3	Left Front Inlet Valve – ABS Code 22
A-4	Left Front Outlet Valve – ABS Code 23
A-5	Right Front Inlet Valve – ABS Code 24
A-6	Right Front Outlet Valve – ABS Code 25
A-7	Rear Inlet Valve – ABS Code 26
A-8	Rear Outlet Valve – ABS Code 27
A-9	Left Front Wheel Speed Sensor – ABS Codes 31, 35, 41, 55, or 75
A-10	Right Front Wheel Speed Sensor – ABS Codes 32, 36, 42, 56, or 76
A-11	Right Rear Wheel Speed Sensor – ABS Codes 33, 37, 43, 57, or 77
A-12	Left Rear Wheel Speed Sensor – ABS Codes 34, 38, 44, 58, or 78
A-13	Missing Wheel Speed Sensor Signals – ABS Codes 45, 46, 47, or 48
A-14	"Pressure Reduction Fault" – ABS Codes 51-54 and 71-74
A-15	Low Fluid/Low Pressure Loop Input Not Processable – ABS Code 61
Chart B	Antilock Lamp On and No ABS Codes Present
B-1	Ignition Enable Circuit
B-2	EBCM (Controller) Loop Circuit Open
B-3	EBCM Loop Short to Ground
B-4	Main Relay Circuits
B-5	Antilock Lamp Circuits
B-6	Miscellaneous EBCM Inputs
Chart C	Brake Lamp On (No Antilock Lamp or ABS Codes) (Without Y67 Reminder Option)
Chart C	Brake Lamp On (No Antilock Lamp or ABS Codes) (With Y67 Reminder Option)
Chart C	Brake Lamp On and No ABS Codes Present
C-1	Brake Pressure Input
C-2	Low Brake Fluid Input
C-3	Parking Brake Input
Chart D	Brake and Antilock Lamps On (#1)
Chart D	Brake and Antilock Lamps On (#2)

D-1	Pump Does Not Run
D-2	Hydraulic Unit Functional Check*
D-3	Fluid Level Sensor
D-4	Extended Pump Operation
D-5	Pressure Switch Performance
D-6	Hydraulic Unit Leakdown
Chart E	Symptom Diagnosis
E-1	Antilock Lamp Inoperative at Key-On
E-2	Antilock Lamp Dim or Inop During Crank
E-3	Valve Cycling (Chatter) During Normal Stops
E-4	Low or Spongy Brake Pedal
E-5	Poor Vehicle Tracking During Antilock Stops
Test F	Wheel Speed Sensor Output
F-1	Right Rear Wheel Speed Sensor Output
F-2	Left Front Wheel Speed Sensor Output
F-3	Left Rear Wheel Speed Sensor Output
F-4	Right Front Wheel Speed Sensor Output
Test G	Solenoid Valves

ABS CODE INDEX

ABS Code	System	Go to Chart
11	EBCM (Controller)	A-1
12	EBCM	A-1
21	Main Valve	A-2
22	LF Inlet Valve	A-3
23	LF Outlet Valve	A-4
24	RF Inlet Valve	A-5
25	RF Outlet Valve	A-6
26	Rear Inlet Valve	A-7
27	Rear Outlet Valve	A-8
31	LF Wheel Speed Sensor	A-9
32	RF Wheel Speed Sensor	A-10
33	RR Wheel Speed Sensor	A-11
34	LR Wheel Speed Sensor	A-12
35	LF Wheel Speed Sensor	A-9
36	RF Wheel Speed Sensor	A-10
37	RR Wheel Speed Sensor	A-11
38	LR Wheel Speed Sensor	A-12
41	LF Wheel Speed Sensor	A-9
42	RF Wheel Speed Sensor	A-10
43	RR Wheel Speed Sensor	A-11
44	LR Wheel Speed Sensor	A-12
45	2 Sensors (LF)	A-13
46	2 Sensors (RF)	A-13
47	2 Sensors (Rear)	A-13
48	3 Sensors	A-13
51	LF Outlet Valve	A-14
52	RF Outlet Valve	A-14
53	Rear Outlet Valve	A-14
54	Rear Outlet Valve	A-14
55	LF Wheel Speed Sensor	A-9
56	RF Wheel Speed Sensor	A-10
57	RR Wheel Speed Sensor	A-11
58	LR Wheel Speed Sensor	A-12
61	EBCM "Loop" Circuit	A-15
71	LF Outlet Valve	A-14
72	RF Outlet Valve	A-14
73	Rear Outlet Valve	A-14
74	Rear Outlet Valve	A-14
75	LF Wheel Speed Sensor	A-9
76	RF Wheel Speed Sensor	A-10
77	RR Wheel Speed Sensor	A-11
78	LR Wheel Speed Sensor	A-12

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LAMP SEQUENCE CHART

Seq. No.	Lamp Sequence								Symptom Description	Perf. Test
	Lamps	Ign. ON	Cranking	Running	Moving	Braking	Stopped	Idle		
1	"ANTILOCK"	▨□	▨	▨□					Normal lamp sequence with: • Excessive pedal travel or spongy pedal • Antilock braking operation or valve cycling during normal stop on dry pavement • Poor vehicle tracking during antilock braking	E F G
	"BRAKE"		■							
2	"ANTILOCK"	▨	▨	▨	▨	▨	▨	▨	Continuous "ANTILOCK" Normal "BRAKE" lamp	A
	"BRAKE"		■							
3	"ANTILOCK"	▨	▨	▨□	□▨	▨	▨	▨	"ANTILOCK" lamp comes ON after vehicle starts moving Normal "BRAKE" lamp	A-9 to A-12 B
	"BRAKE"		■							
4	"ANTILOCK"	▨□		▨□					No "ANTILOCK" lamp while cranking Normal "BRAKE" lamp	E-2
	"BRAKE"		■							
5	"ANTILOCK"								No "ANTILOCK" lamp Normal "BRAKE" lamp	E-1
	"BRAKE"		■							
6	"ANTILOCK"	▨	▨	▨□	□▨	▨	▨		Intermittent "ANTILOCK" while driving Normal "BRAKE" lamp	B
	"BRAKE"		■							
7	"ANTILOCK"	▨	▨	▨	▨	▨	▨	▨	Continuous "ANTILOCK" lamp Continuous "BRAKE" lamp	D
	"BRAKE"	■	■	■	■	■	■	■		
8	"ANTILOCK"	▨	▨	▨□		□▨			"ANTILOCK" and "BRAKE" lamps come ON while braking	C
	"BRAKE"	■	■			□■				
9	"ANTILOCK"	▨□	▨	▨□					Normal "ANTILOCK" lamp Continuous "BRAKE" lamp	C
	"BRAKE"	■	■	■	■	■	■	■		

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PINOUT CHECKS

- Connect break-out box J-35592 to 3-pin ECBM harness connector as described in this section.
- Perform checks with high impedance digital multimeter J-34029-A, or equivalent.
- All checks are made with engine stopped.

Circuit To Be Tested	Ignition Switch Position	Multimeter Scale/Range	Measure Between Pin Numbers	Specification	If Result Not Within Specification, See Chart
Ignition Enable	RUN	20 DCV	2(+)* .1(-)*	10V Minimum	B-1
Main Relay Ground	OFF	200 Ω	1, 3	Continuity	B-4
	OFF	200 Ω	1, 20	Continuity	
Main Relay Coil	OFF	200 Ω	1, 8	45-105 Ω	B-4
Before performing this test: • Remove Gauge fuse from fuse panel. • Place fused jumper between break-out box pins 2 and 8.					
Main Relay Power	ON	20 DCV	3(+) .1(-)	10V Minimun	B-4
	ON	20 DCV	20(+) .1(-)	10V Minimun	
Before proceding: • Remove jumper from pins 2 and 8. • Install gauge fuse.					
EBCM Switch Loop	OFF	200 Ω	9, 10	Less than 5 Ω	A-15
	OFF	200 Ω	1, 9	No Continuity	A-15
RR Sensor Resistance	OFF	2 kΩ	4, 22	800-1400 Ω	A-11
LF Sensor Resistance	OFF	2 kΩ	5, 23	800-1400 Ω	A-9
LR Sensor Resistance	OFF	2 kΩ	6, 24	800-1400 Ω	A-12
RF Sensor Resistance	OFF	2 kΩ	7, 25	800-1400 Ω	A-10
Main Valve Solenoid	OFF	200 Ω	11, 18	2-5 Ω	A-2
Valve Block Ground	OFF	200 Ω	1, 11	Less than 2 Ω	A-3 to A-7
RF Inlet Valve	OFF	200 Ω	11, 15	5-7 Ω	A-5
LF Inlet Valve	OFF	200 Ω	11, 35	5-7 Ω	A-3
Rear Inlet Valve	OFF	200 Ω	11, 17	5-7 Ω	A-7
RF Outlet Valve	OFF	200 Ω	11, 34	3-5 Ω	A-6
LF Outlet Valve	OFF	200 Ω	11, 16	3-5 Ω	A-4
Rear Outlet Valve	OFF	200 Ω	11, 33	3-5 Ω	A-8
Before performing this test: • Remove main relay from connector on relay bracket (five wires attached).					
Diode	OFF	Diode —|◀—	27(+), 3(-)	Continuity	E-1
	OFF	Diode —|◀—	3(+), 27(-)	No Continutiy	
Before proceeding: • Install main relay.					
Brake Light Switch (Some Applications)	• With brake pedal released.				
	ON	20 DCV	12(+), 1(-)	0V	B-6
Brake Light Switch (Some Applications)	• With brake pedal applied.				
	ON	20 DCV	12(+), 1(-)	10V Minimun	B-6

*(+) or (-) indicates multimeter polarity.

If all test results are within specification, reconnect EBCM and verify continuous "ANTILOCK" lamp operation.

- If normal operation resumes, see note on intermittents.
- If lamp remain ON, see chart B-5.

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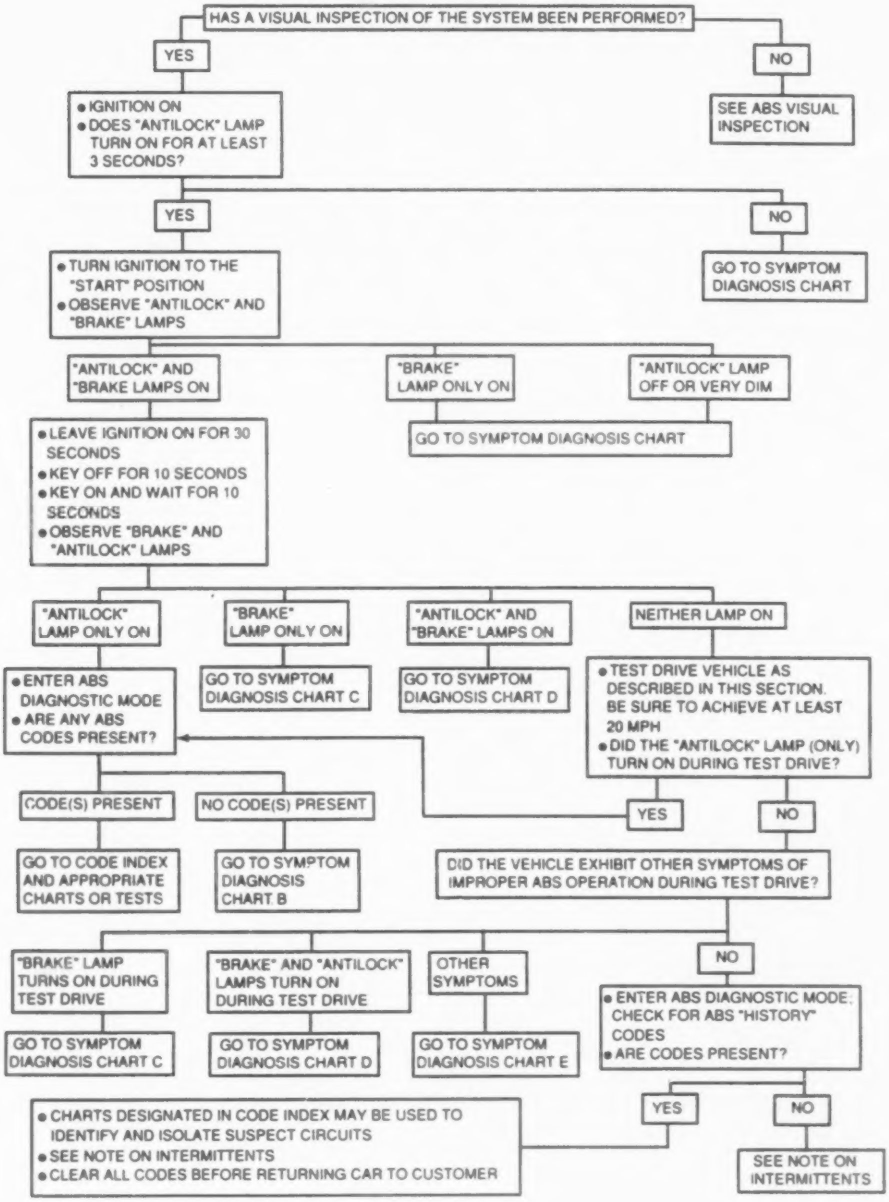
ABS FUNCTIONAL CHECK


HAS A VISUAL INSPECTION OF THE SYSTEM BEEN PERFORMED?
YES
NO
SEE ABS VISUAL INSPECTION
• IGNITION ON
• DOES "ANTILOCK" LAMP TURN ON FOR AT LEAST 3 SECONDS?
YES
NO
GO TO SYMPTOM DIAGNOSIS CHART
• TURN IGNITION TO THE "START" POSITION
• OBSERVE "ANTILOCK" AND "BRAKE" LAMPS
"ANTILOCK" AND "BRAKE LAMPS ON
"BRAKE" LAMP ONLY ON
"ANTILOCK" LAMP OFF OR VERY DIM
GO TO SYMPTOM DIAGNOSIS CHART
• LEAVE IGNITION ON FOR 30 SECONDS
• KEY OFF FOR 10 SECONDS
• KEY ON AND WAIT FOR 10 SECONDS
• OBSERVE "BRAKE" AND "ANTILOCK" LAMPS
"ANTILOCK" LAMP ONLY ON
"BRAKE" LAMP ONLY ON
"ANTILOCK" AND "BRAKE" LAMPS ON
NEITHER LAMP ON
• ENTER ABS DIAGNOSTIC MODE
• ARE ANY ABS CODES PRESENT?
GO TO SYMPTOM DIAGNOSIS CHART C
GO TO SYMPTOM DIAGNOSIS CHART D
• TEST DRIVE VEHICLE AS DESCRIBED IN THIS SECTION. BE SURE TO ACHIEVE AT LEAST 20 MPH
• DID THE "ANTILOCK" LAMP (ONLY) TURN ON DURING TEST DRIVE?
CODE(S) PRESENT
NO CODE(S) PRESENT
YES
NO
GO TO CODE INDEX AND APPROPRIATE CHARTS OR TESTS
GO TO SYMPTOM DIAGNOSIS CHART B
DID THE VEHICLE EXHIBIT OTHER SYMPTOMS OF IMPROPER ABS OPERATION DURING TEST DRIVE?
"BRAKE" LAMP TURNS ON DURING TEST DRIVE
"BRAKE" AND "ANTILOCK" LAMPS TURN ON DURING TEST DRIVE
OTHER SYMPTOMS
NO
• ENTER ABS DIAGNOSTIC MODE; CHECK FOR ABS "HISTORY" CODES
• ARE CODES PRESENT?
GO TO SYMPTOM DIAGNOSIS CHART C
GO TO SYMPTOM DIAGNOSIS CHART D
GO TO SYMPTOM DIAGNOSIS CHART E
YES
NO
• CHARTS DESIGNATED IN CODE INDEX MAY BE USED TO IDENTIFY AND ISOLATE SUSPECT CIRCUITS
• SEE NOTE ON INTERMITTENTS
• CLEAR ALL CODES BEFORE RETURNING CAR TO CUSTOMER
SEE NOTE ON INTERMITTENTS

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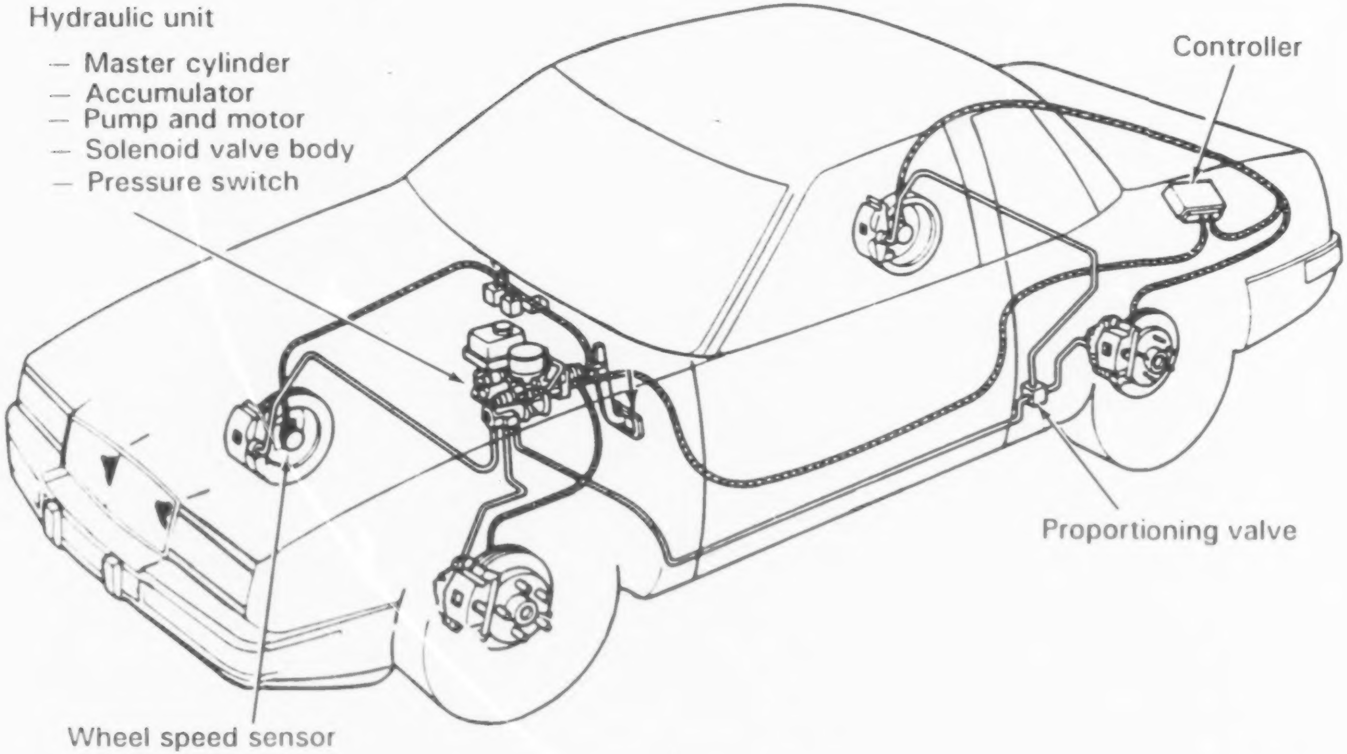
TRANSPARENCY MASTER 1 · Brakes Specialist
CIMC · IV · 65

Four-Wheel Antilock Brake System


Hydraulic unit
— Master cylinder
— Accumulator
— Pump and motor
— Solenoid valve body
— Pressure switch
Controller
Proportioning valve
Wheel speed sensor

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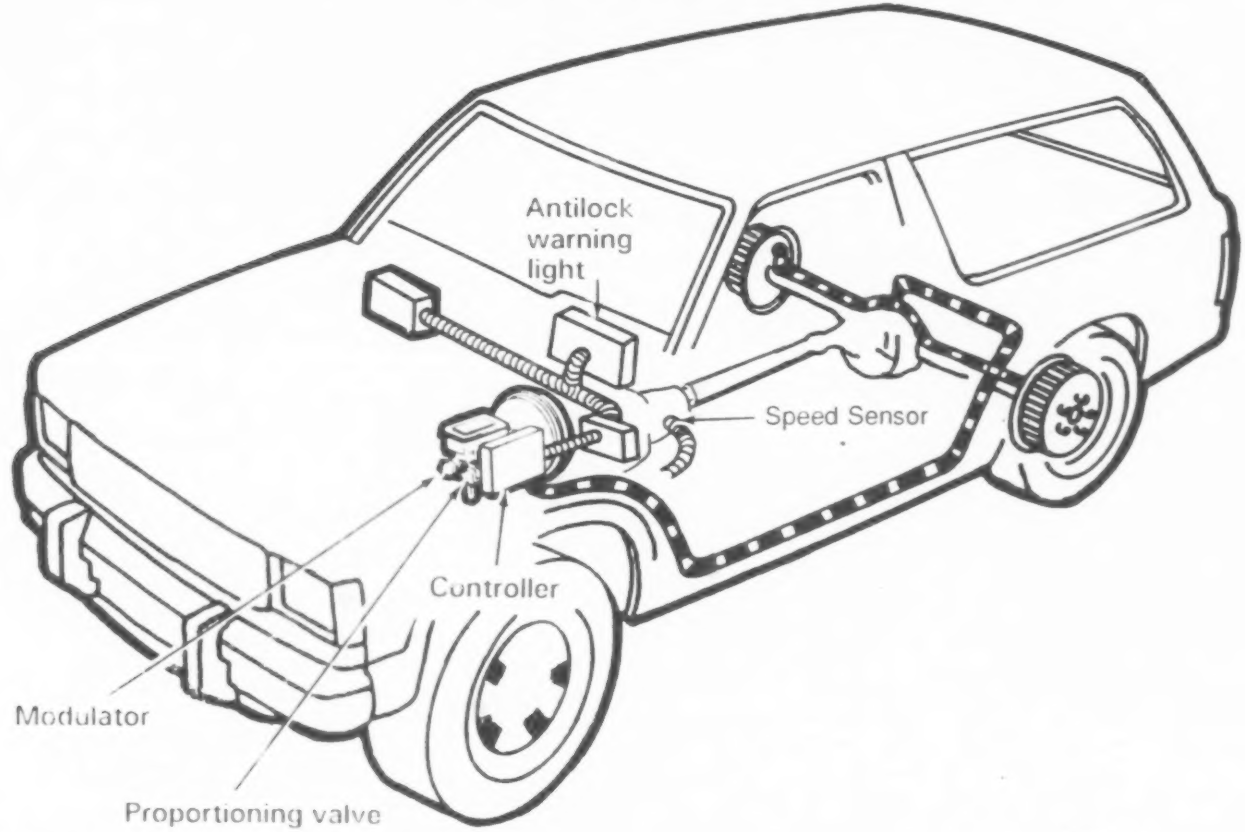
Rear-Wheel Antilock Brake System


Antilock
warning
light
Speed Sensor
Controller
Modulator
Proportioning valve

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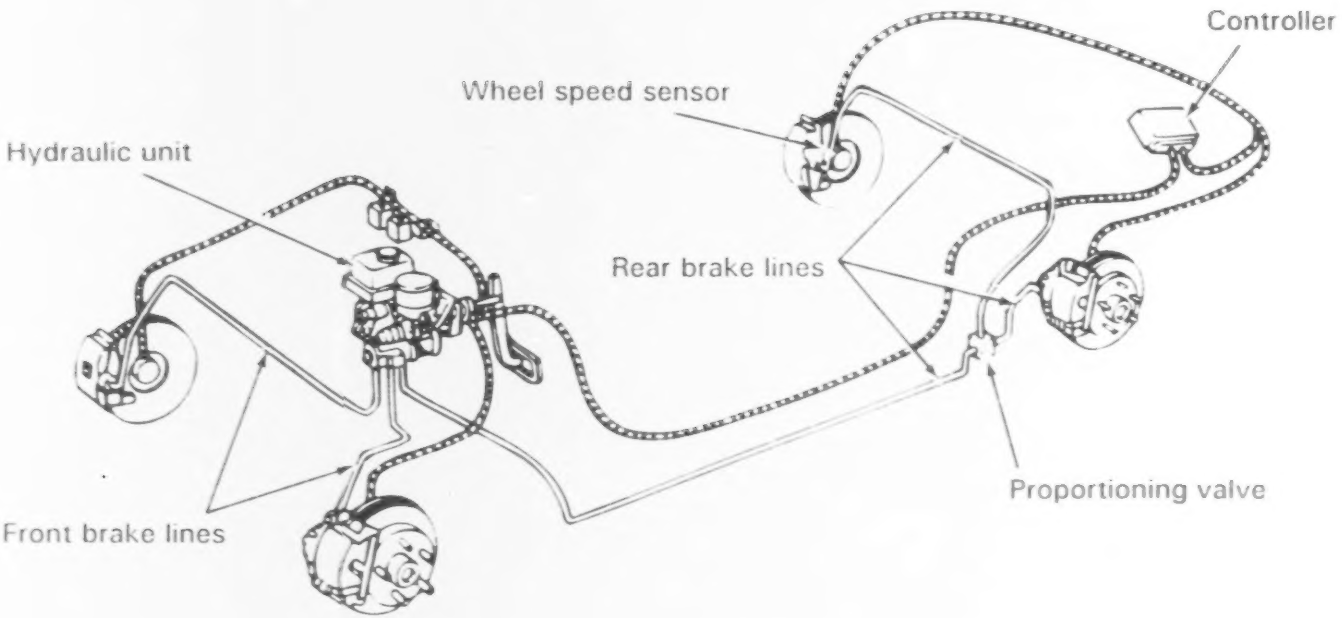
Teves ABS


Controller
Wheel speed sensor
Hydraulic unit
Rear brake lines
Front brake lines
Proportioning valve

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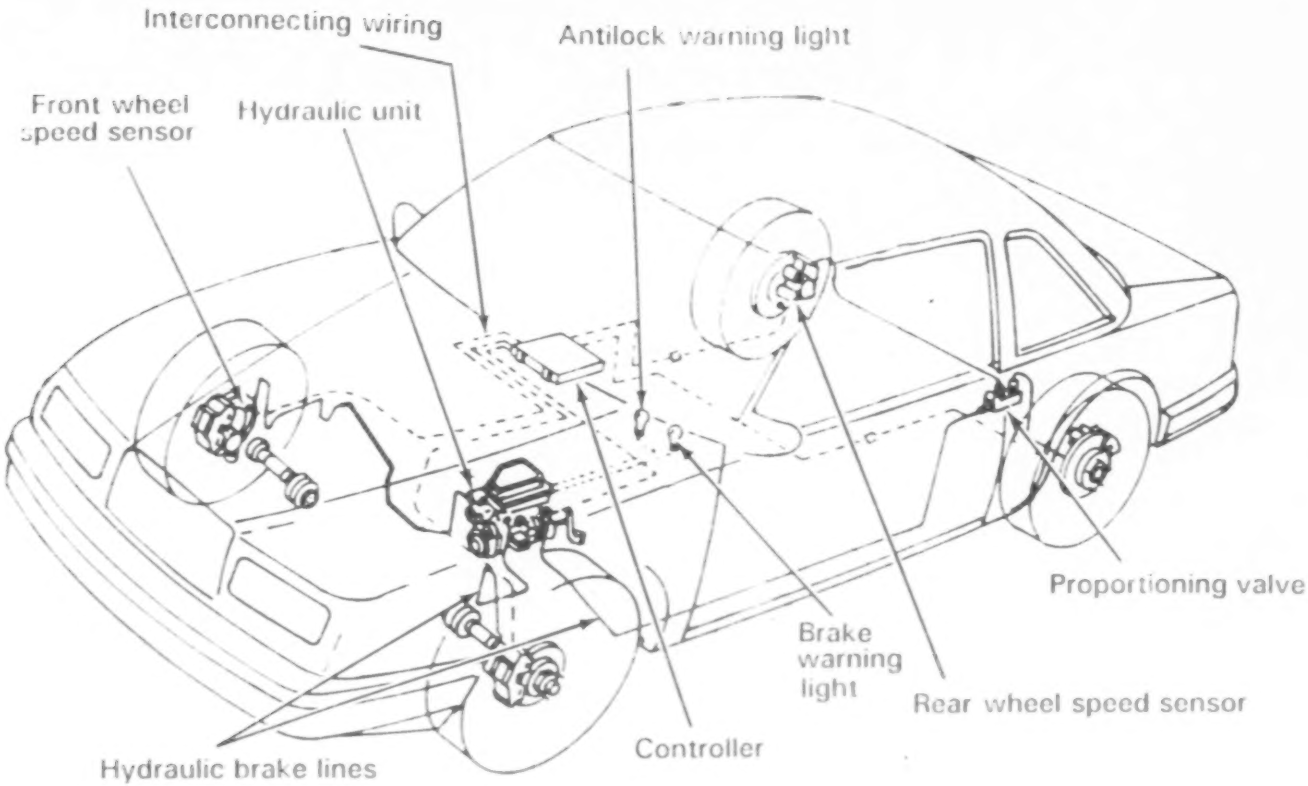
Delco Moraine ABS


Interconnecting wiring
Antilock warning light
Front wheel speed sensor
Hydraulic unit
Proportioning valve
Brake warning light
Rear wheel speed sensor
Controller
Hydraulic brake lines

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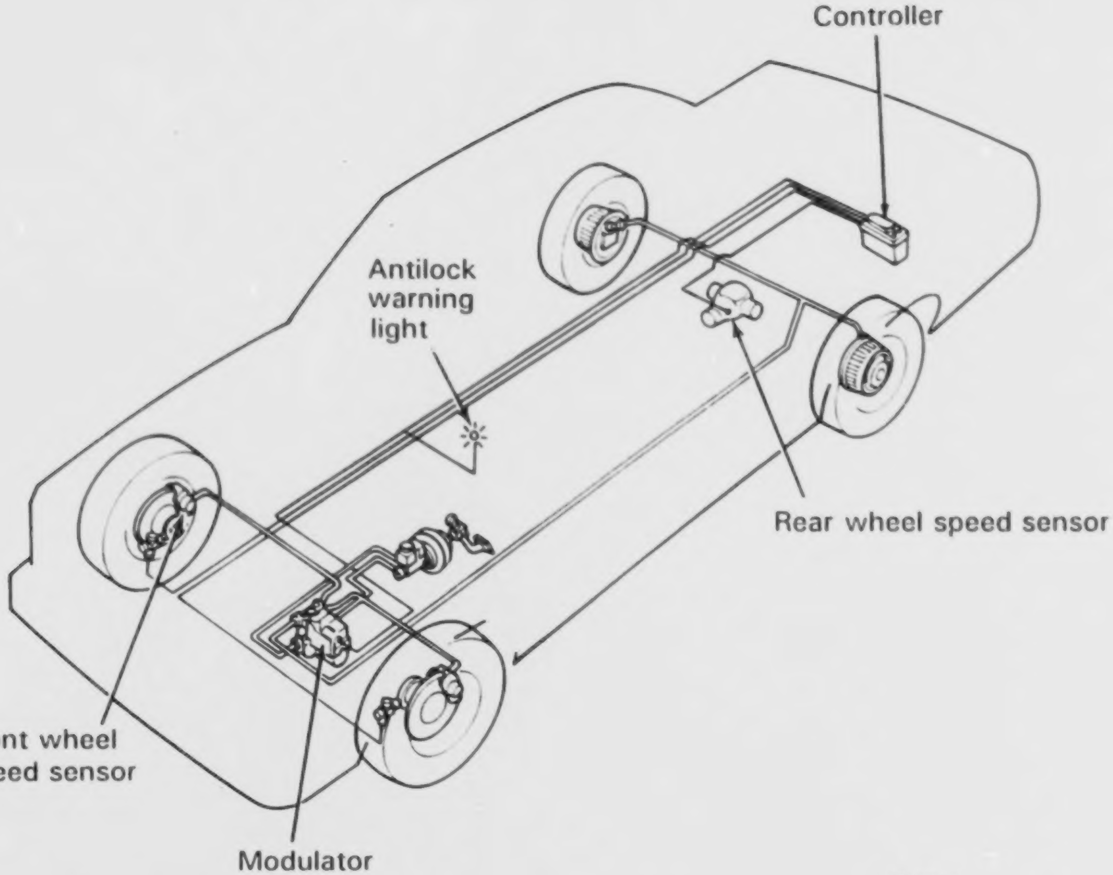
Bosch ABS 2U


Controller
Antilock warning light
Rear wheel speed sensor
Front wheel speed sensor
Modulator

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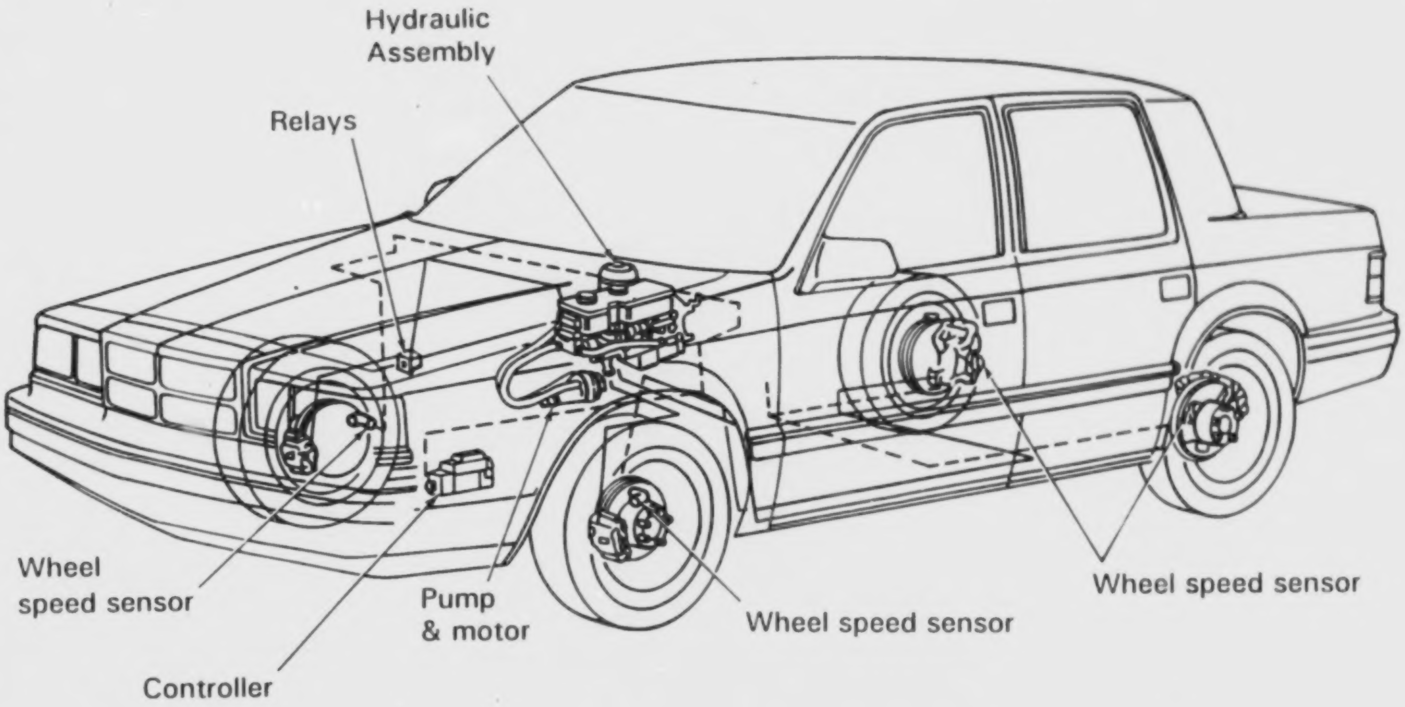
Bendix ABS


Hydraulic Assembly
Relays
Wheel speed sensor
Pump & motor
Controller
Wheel speed sensor
Wheel speed sensor

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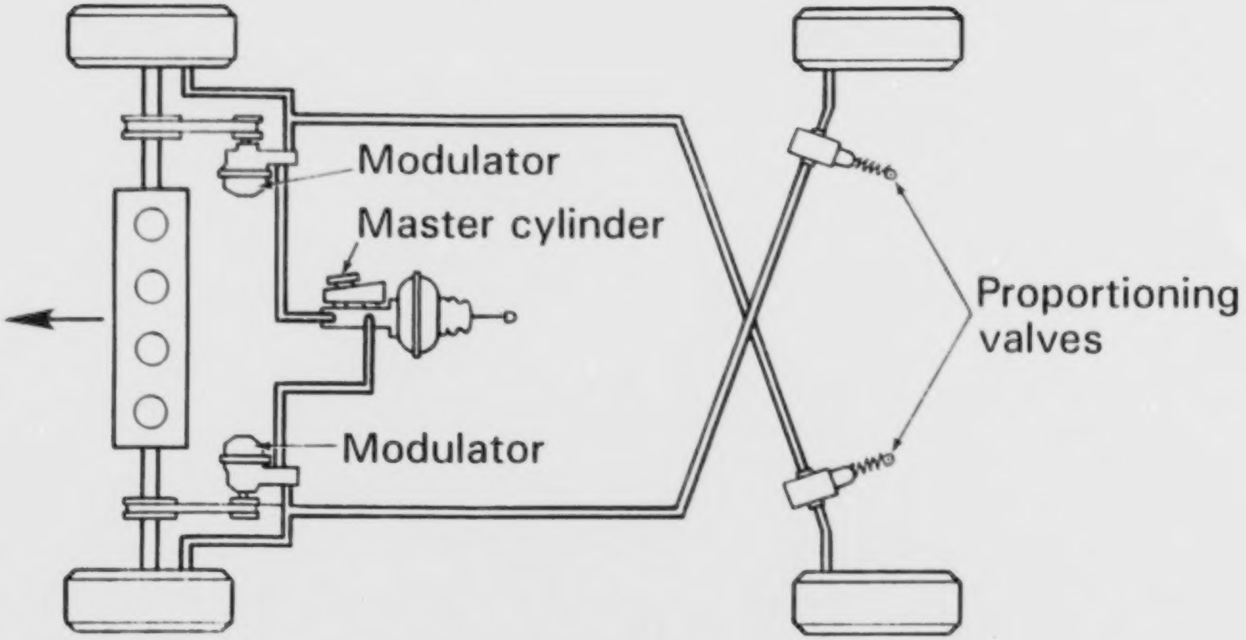
Lucas-Girling SCS


Modulator
Master cylinder
Proportioning valves
Modulator

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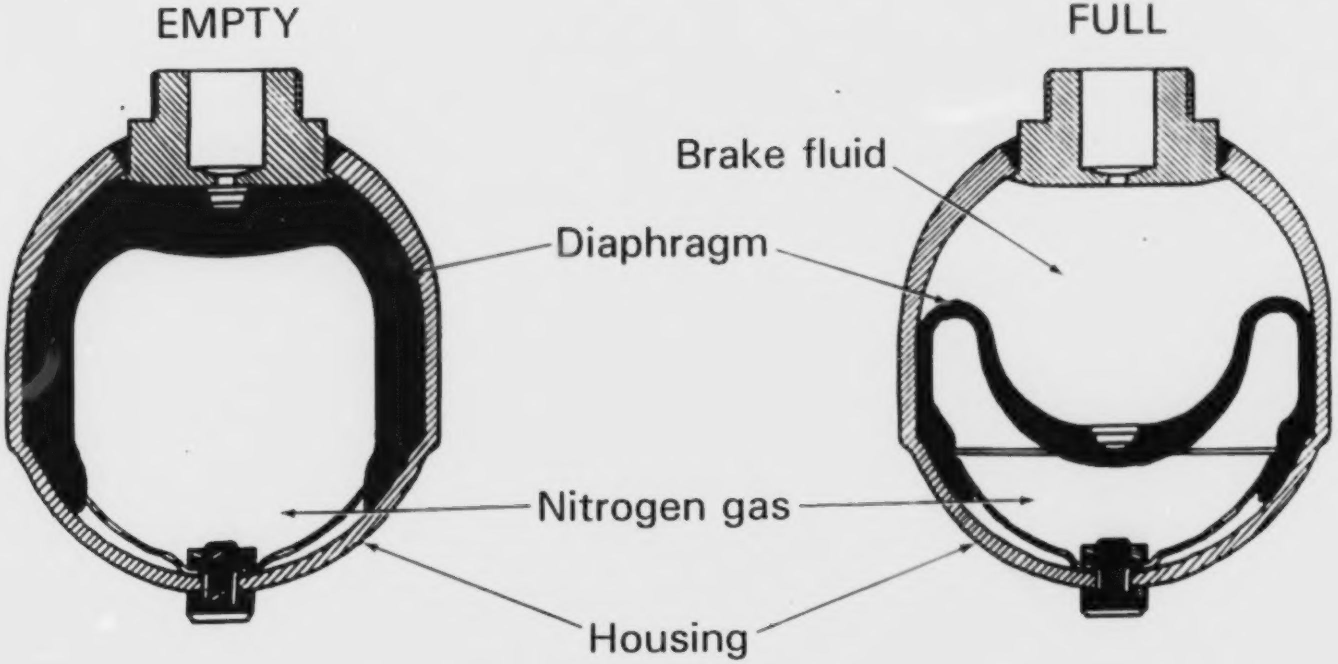
Accumulator


EMPTY
FULL
Brake fluid
Diaphragm
Nitrogen gas
Housing

TRANSPARENCY MASTER 8 · Brakes Specialist

CIMC · IV · 79

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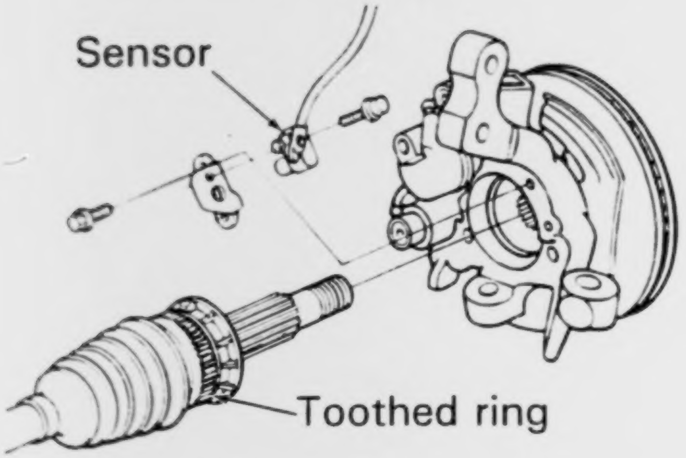
TM 8

Rear Wheel Speed Sensor
— Axle Mounted


Sensor
Toothed ring

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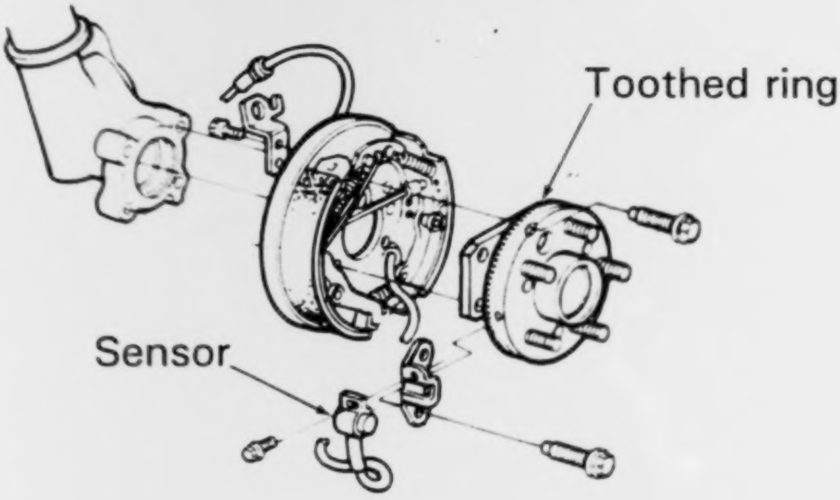
Rear Wheel Speed Sensor
— Hub Mounted


Toothed ring
Sensor

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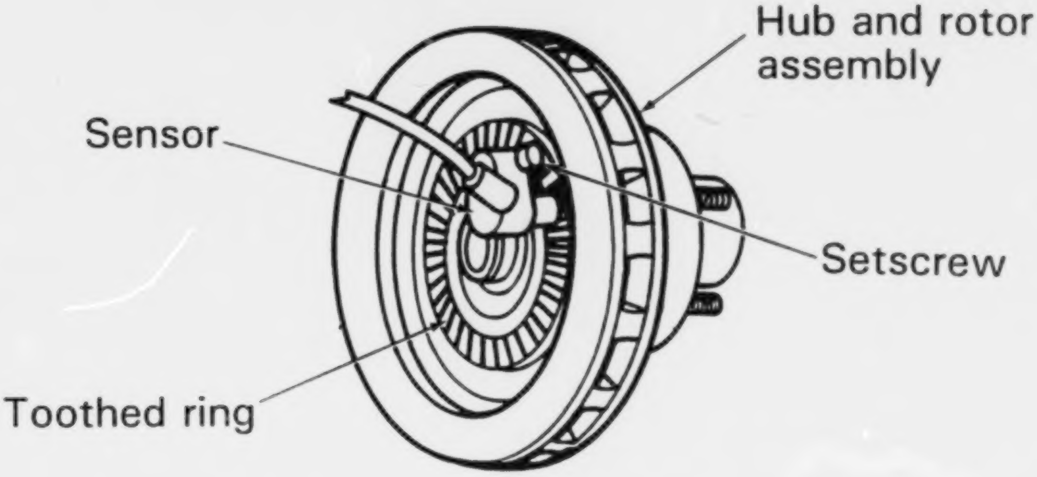
Front Wheel Speed Sensor


Hub and rotor assembly
Sensor
Setscrew
Toothed ring

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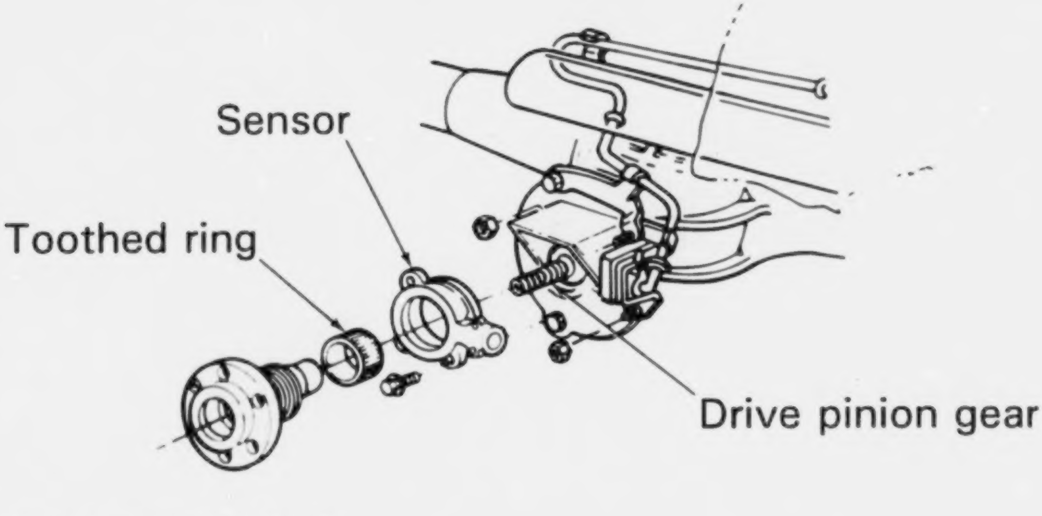
Drive Pinion Gear Wheel Speed Sensor


Sensor
Toothed ring
Drive pinion gear

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ACTIVITY SHEET 1

Development of:
READING SKILLS

- Introduce the assignment to the students by discussing why reading skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING

  - Drawing conclusions
  - Interpreting abbreviations/acronyms

- If students have difficulty drawing conclusions:
  - Have students list what is known.
  - Have students identify what is indicated by information presented.
  - Have students list possible conclusions and determine why each is or is not probable.
- If students have difficulty using content area vocabulary:
  - Stress the importance of learning automotive terminology.
  - Have them review parts and part names in the brake system.
  - Define or describe terms as you use them.
  - Have students list terms they are not sure of and look them up. Then pair these students with more skilled students and have them say the vocabulary words and indicate the appropriate part of process on an exhaust system.

Reading Comprehension Skills
- Draw conclusions

Functional Reading Skills
- Interpret abbreviations/ acronyms

Name______________________________ Score ________

ANSWER GENERAL QUESTIONS ABOUT ANTILOCK BRAKE SYSTEMS

To become certified as a Brakes Specialist, you must pass a test on brake systems compiled by the National Institute for Automotive Service Excellence. The certification test covers all aspects of the vehicle's brake system. This activity sheet covers only antilock brake systems, but it contains questions similar in content and style to those found on the actual ASE certification test.

Read each of the following questions twice. The second time you may notice a key word that you overlooked the first time. Every word in a question is important and may provide a clue to the right answer. Select the answer that is **most** correct and write its letter in the answer blank.

______ 1. Technician A attempts to bleed an antilock brake system with the accumulator charged. Technician B states that you must first discharge the accumulator and then bleed the system with a pressure bleeder. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 2. ABS systems

a. Can control front brakes individually or together
b. Cannot control front brakes individually
c. Always control rear brakes individually
d. Can control rear brakes individually or together

_____ 3. Under normal driving conditions, the antilock brake system

a. Does not operate
b. Functions the same as a standard brake system
c. Functions as a parking brake
d. Functions only when the transmission is in high

_____ 4. Which warning light signals a possible malfunction in the antilock brake system?

a. The red BRAKE light
b. The amber ANTILOCK light
c. The CHECK ENGINE light
d. None of these

_____ 5. Which of the following is **not** a process involved in the antilock control cycle?

a. Eliminate pressure
b. Maintain pressure
c. Reduce pressure
d. Increase pressure

_____ 6. If an intermittent fault cannot be diagnosed using the antilock warning light sequence chart, the problem will most likely be caused by a defective

a. Controller
b. Electrical connection
c. Chart
d. Sensor

_____ 7. Which of the following brake fluid classifications should be used in vehicles having antilock brake systems?

a. DOT 1
b. DOT 2
c. DOT 3
d. DOT 5

_____ 8. When measuring wheel sensor operation using a digital multimeter, where should the selector be set?

a. Ohms x 1000
b. Ohms x 10
c. DC Volts, 12 volt scale
d. AC Volts, 2 volt scale

_____ 9. When you encounter a defective solenoid valve body on a rear-wheel antilock brake system, you should

a. Rebuild the unit
b. Replace the unit
c. Adjust the unit
d. Any of these are acceptable

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_____ 10. Technician A says that no rear-wheel antilock brake systems use wheel speed sensors on both rear wheels. Technician B says that rear-wheel antilock brake systems do not use a proportioning or metering valve. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 11. The antilock warning light stays on for a few seconds after starting the vehicle, then goes out. Technician A says that this is a normal self-test function. Technician B says that this indicates an intermittent problem in the antilock system. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 12. When the ABS controller senses impending right front wheel lockup, the hydraulic pressure will be controlled at the

a. Rear wheels
b. Right front wheel
c. Left front wheel
d. All four wheels

_____ 13. Antilock brake systems are designed

a. With more powerful brakes to provide quicker stops
b. To provide a warning system informing the driver of impending wheel lockup
c. To reduce power brake assist on icy roads
d. To prevent wheel lockup during stops

_____ 14. As the wheels rotate on a vehicle with antilock brakes, the wheel sensors provide an electrical signal to the controller that

a. Increases with the speed of the vehicle
b. Decreases with the speed of the vehicle
c. Both a and b
d. Neither a nor b

_____ 15. Which of the following can cause the controller to set a code indicating a problem with the right front wheel speed sensor?

a. Loose front wheel bearing
b. Improper sensor air gap
c. Loose connector
d. All of these

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ACTIVITY SHEET ANSWERS

SERVICING ANTILOCK BRAKE SYSTEMS

IV

ACTIVITY SHEET 1

1. b
2. d
3. b
4. b
5. a
6. b
7. c
8. d
9. b
10. a
11. a
12. b
13. d
14. c
15. d

ASSIGNMENT SHEET 1

Development of:
READING SKILLS

- Introduce the assignment to the students by discussing why reading skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING

  - Drawing conclusions
  - Using standard references
  - Using in-book references
  - Interpreting graphics & symbols

- If students have difficulty using standard references:
  - Locate and explain the purpose of the reference section of the library.
  - Discuss the fact that each standard reference provides a specific type of information.
  - Review each element of the service manual that might be used, including exploded illustrations, rotated illustrations, parts lists, allowable variance charts, and procedure instructions. Discuss the use for and importance of each element.
  - Review the use of other references, including computer data bases and telephone help lines.
- If students have difficulty using in-book reference tools:
  - Show students various in-book reference tools, including tables of content, supplements, illustrations, and unit objective statements. Identify the content of each and have students identify how each can be used for easy access to text information.

  - Encourage students to use bookmarks or other devices to mark most-used in-book references.
  - Explain to students that books are "random access" tools, meaning the information in them is accessible in any order. Compare books to items which are not random access such as cassette tapes or video films.
  - Have students create their own in-book references by keeping word lists, glossaries, time lines, or lecture notes and relating each piece of information to its textbook location.
- If students have difficulty interpreting graphics and symbols, review the structure of the chart.
- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1.

ASSIGNMENT SHEETS 2 & 3

Development of:
READING SKILLS

- Introduce the assignment to the students by discussing why reading skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING

  - Drawing conclusions
  - Using standard references
  - Using in-book references
  - Interpreting graphics & symbols
  - Using content area vocabulary
  - Interpreting abbreviations/acronyms

- If students have difficulty using content area vocabulary:
  - Stress the importance of learning automotive terminology.
  - Have them review parts and part names in the braking system.

  - Define or describe terms as you use them.
  - Have students list terms they are not sure of and look them up. Then pair these students with more skilled students and have them say the vocabulary words and indicate the appropriate braking system part or component.
  - Review key terms and concepts, encouraging students to hear, see, write, and say them.
- For additional suggestions on teaching basic skills, refer to suggestions for Activity Sheet 1 and Assignment Sheet 1.

ASSIGNMENT SHEET 1

SERVICING ANTILOCK BRAKE SYSTEMS

IV

Name ______________ ______________ **Score** ________

OBJECTIVE 10

Diagnose pedal feel to determine antilock brake system operation problems.

INTRODUCTION

Antilock brake features operate only when you need them. The rest of the time, antilock brake systems function the same as standard brake systems. Most antilock systems are computer controlled and perform a self-test whenever the vehicle is started. If a failure is detected by the controller, the controller turns on the antilock warning light on the instrument panel.

When the antilock system is in operation (when it is actually keeping the wheels from lockup), the brake pedal will pulsate slightly. Drivers who are unfamiliar with this normal operating condition, feeling this pulsation, may think that the brake rotors or drums are warped.

At startup when the antilock system is performing its self-test, the controller cycles the valves in the solenoid valve body as the vehicle begins to move. When the valves are being cycled, the driver may hear a clicking sound and be concerned. This is a normal sound caused by the cycling.

In order to properly diagnose pedal feel, it is necessary to road test the vehicle. Use Supplement 1, *Making a Diagnostic Road Test*, to help you make this test.

DIRECTIONS

Study the introduction to this Assignment Sheet and use Supplement 1, *Making a Diagnostic Road Test*, and Supplement 2, *Brake Pedal Feel*, to help you with this Assignment Sheet. Read each of the following questions carefully, then select the answer for each that is **most** correct. Write the correct letter in the blank.

Reading Comprehension Skills
- Draw conclusions

Research and Reference Skills
- Use standard references
- Use in-book reference tools

Functional Reading Skills
- Interpret graphics & symbols

_____ 1. When checking brake pedal feel on a vehicle with antilock brakes, you discover that the pedal is low and spongy. The most likely cause of this is

a. Misaligned brake linings
b. A leak in the master cylinder
c. Accumulator failure
d. Air in the system

_____ 2. Technician A says that consulting the service manual is the first thing he does when getting ready to make a diagnostic road test. Technician B says that she first listens to the vehicle's owner and asks questions about the problem. Whose procedure is recommended?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 3. The customer complains that the brake pedal on his vehicle with antilock brakes pulsates. Your road test on a sunny day cannot duplicate the problem. What is the most likely cause?

a. The front brake rotors are warped
b. Nothing, this condition is normal
c. The antilock system is making a self-test
d. The rear brake shoes are loose

_____ 4. What is the correct action to remedy a master cylinder pushrod that is not engaging properly?

a. Replace the pushrod
b. Repair the pushrod
c. Repair the pushrod mounting
d. Replace the master cylinder

_____ 5. The customer complains that the antilock brakes are hard to apply. When you depress the pedal with the key off, the pedal feels hard. What component is most likely at fault?

a. Pump and motor
b. Accumulator
c. Master cylinder
d. None of these

_____ 6. If the brake pedal goes to the floor on a vehicle with an antilock brake system, it usually indicates

a. Air in the system
b. Worn brake parts
c. Loss of brake fluid from leaks
d. Loss of accumulator pressure

_____ 7. A customer reports strange clicking noises under the hood whenever she starts the car. Technician A says this is a normal condition. Technician B checks to see if the car has antilock brakes before giving an opinion. Who is right?

   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B

_____ 8. Why should you check the service manual troubleshooting guide before road testing a vehicle?

   a. To see if the customer's opinion of the problem could be right
   b. To check the type of accumulator found on the vehicle
   c. To see what types of tests you should make during the road test
   d. To see if it is safe to road test the vehicle

ASSIGNMENT SHEET 2

SERVICING ANTILOCK BRAKE SYSTEMS

IV

Name ________________________________ **Score** __________

OBJECTIVE 11

Diagnose antilock brake system hydraulic system problems.

INTRODUCTION

Diagnosis of antilock problems can be very complicated. Tracing the source of an antilock problem usually involves testing the system using a large number of troubleshooting and diagnostic charts. Look at the list of diagnostic charts for the Teves ABS in Supplement 7. Learning to use charts such as these is an important part of a Brake Technician's training. Assignment Sheets 2 and 3 will give you some experience in this necessary skill.

DIRECTIONS

Reading Comprehension Skills
- Draw conclusions

Research and Reference Skills
- Use standard references (dictionary, encyclopedia.
- Use in-book reference tools

Functional Reading Skills
- Interpret graphics & symbols
- Use content area vocabulary
- Interpret abbreviations/acronyms

Use Supplements 3, 4, 5, 6, 7, 8, and 9 to help you answer the following questions. (Supplement 3, *Troubleshooting Antilock Problems*; Supplement 4, *ABS Visual Inspection*; Supplement 5, *Hydraulic Unit Functional Check*; Supplement 6, *ABS Problem Diagnosis Chart*; Supplement 7, *Teves ABS Diagnostic Charts*; Supplement 8, *ABS Code Index*; and Supplement 9, *Lamp Sequence Chart*) Read each of the following questions carefully, select the most correct answer, and write the letter of that answer in the blank provided. Make no assumptions other than the information given.

_____ 1. What Teves diagnostic chart would you use if the pump continued to run for over 45 seconds when the accumulator is being charged?

a. A-14
b. C-1
c. D-1
d. D-4

_____ 2. During a visual inspection for hydraulic problems, Technician A is checking connectors and fuses. Technician B says that checking electrical components during an inspection for hydraulic problems is a waste of time. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 3. During your road test of a vehicle, the brakes work normally, but on a gravel road the vehicle skids. What hydraulic problem could cause this?

a. Defective wheel speed sensor
b. Leak in the hydraulic system
c. Defective proportioning valve
d. Blown antilock fuse or diode

_____ 4. During your hydraulic unit functional check, you discover that the pre-charge pressure is 400 psi. What component should be replaced?

a. Accumulator
b. Master cylinder
c. Pump and/or motor
d. No component replacement is necessary

_____ 5. In an attempt to locate the reason why a vehicle with antilock brakes is skidding, you pressure test the proportioning valve and find that it is defective. What must be done to correct this ?

a. Adjust the proportioning valve
b. Repair the proportioning valve
c. Replace the proportioning valve
d. Replace the solenoid valve body

_____ 6. During an antilock warning light sequence test, both the brake light and the antilock light are lit continuously. Technician A looks at the diagnostic charts for this condition and says he thinks there is probably a hydraulic problem. Technician B looks at the charts and disagrees. Who is right?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 7. While descending a mountain or a steep hill, the ABS vehicle owner states that the brakes begin to fade. After some questions about vehicle maintenance, the technician determines what the problem is and repairs it. What did the technician do to fix this problem ?

a. Replaced the master cylinder
b. Adjusted the brakes
c. Flushed the brake system
d. Replaced the accumulator

_____ 8. Your ABS service manual suggests that you connect a scanner during your road test. The scanner shows you a code 22. What antilock component is involved?

a. Controller
b. Wheel speed sensor
c. Solenoid valve body
d. Accumulator

_____ 9. During the antilock warning light sequence test, the brake light is normal, and there is an intermittent antilock warning light. What type of problem is indicated?

a. Electrical
b. Hydraulic
c. Regular brake component
d. None of the above

_____ 10. What test is used to diagnose an internal brake fluid leak?

a. Visual inspection
b. Functional check
c. Antilock warning light sequence test
d. Pressure diagnosis tests

_____ 11. If the antilock warning light sequence test is normal, but the pedal is spongy, what chart should be used to help diagnose the problem?

a. A
b. B
c. C
d. E

_____ 12. During a visual inspection, you notice that the brake fluid is below the normal mark in the reservoir. What action do you take?

a. None; this is a normal condition when the accumulator is pressurized
b. Add brake fluid
c. Add brake fluid and determine the cause of loss
d. Add brake fluid, determine the cause of loss, and remedy it

ASSIGNMENT SHEET 3

SERVICING ANTILOCK BRAKE SYSTEMS

IV

Name ______________________________ **Score** __________

OBJECTIVE 12

Diagnose antilock brake system electronic control system problems.

INTRODUCTION

Antilock electronic control system problems are tested through the controller. On vehicles without code diagnostics, an *antilock warning light sequence test* is made to help you analyze this information. The vehicle service manual will tell you how to make this test. The procedures for the test are also given in Job Sheet 1.

If the vehicle has code diagnostics, a *functional check* is made which combines tests made during an antilock warning light sequence test with tests made using a scanner or a multimeter and breakout box. Code charts such as the one in Supplement 8 indicate the faulty components. The Brakes Technician must not assume that a code indicates that the component must be replaced. A fault code means only that a electrical impulses from that component are not normal. The problem could be anything from a loose wiring connector to a faulty solenoid. The only way to be sure of the problem is to test the circuit according to the procedures outlined by the manufacturer.

DIRECTIONS

Reading Comprehension Skills
- Draw conclusions

Research and Reference Skills
- Use standard references
- Use in-book reference tools

Functional Reading Skills
- Interpret graphics & symbols
- Use content area vocabulary
- Interpret abbreviations/acronyms

Use Supplements 1, 3, 4, 6, 7, 8, 9, 10, and 11 to help you answer the following questions. (Supplement 1, *Making a Diagnostic Road Test*; Supplement 3, *Troubleshooting Antilock Problems*; Supplement 4, *ABS Visual Inspection*; Supplement 6, *ABS Problem Diagnosis Chart*; Supplement 7, *Teves ABS Diagnostic Charts*; and Supplement 8, *ABS Code Index*; Supplement 9, *Lamp Sequence Chart*; Supplement 10,

Pinout Checks; and Supplement 11, *ABS Functional Check*) Read each of the following questions carefully, select the most correct answer, and write the letter of that answer in the blank provided. Make no assumptions other than the information given.

_____ 1. A vehicle with an antilock brake system flashes a code 12. The first check that should be made is the

a. Main valve
b. RF wheel speed sensor
c. Controller
d. EBCM loop circuit

_____ 2. During a test drive the antilock warning light comes on intermittently, but the brake light is normal. Which test should be done next?

a. Diagnostic test A
b. Diagnostic test B
c. Diagnostic test D
d. Diagnostic test E

_____ 3. When testing wheel sensor resistance, the technician discovers that the wheel sensor on the left rear wheel reads 950 ohms. Technician A states that this is too high. Technician B says that it falls within an acceptable range. Who is right ?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 4. A customer complains that the brakes are not working when he applies them to stop. On your road test, what antilock warning light sequence will probably show up?

a. Antilock light on constantly
b. Brake light on constantly
c. Both lights work normally
d. None–you do not make a road test

_____ 5. Both the antilock and the brake light performed normally when the ignition was on, but when you turned the ignition to start, the brake lamp went off. Should you do next?

a. Enter ABS diagnostic mode
b. Go to the code index and appropriate charts or tests
c. Go to symptom diagnosis chart E
d. Retest the system

_____ 6. What should the voltage be to the main relay?

a. 45-105 ohms
b. 2-5 ohms
c. 10 V minimum
d. voltage not specified

_____ 7. On a test drive, the technician notices that the brakes fade. What test should he perform?

a. Antilock warning light sequence check
b. Brake fluid check
c. Pinout check
d. Accumulator leakdown test

_____ 8. During a functional test on the vehicle, a road test is recommended. How fast should you go?

a. Very slow
b. At least 20 mph
c. Highway speeds
d. Various speeds

_____ 9. What breakout box should be used for Teves pinout checks?

a. Teves breakout box
b. Standard breakout box
c. J-34029-A
d. J-35592

_____ 10. Which of the following conditions can cause the controller to set a code 55?

a. Defective component
b. Loose connector
c. Blown fuse
d. All of the above

_____ 11. A customer complains that his vehicle with antilock brakes is skidding on slick roads. Technician A says that you should enter into ABS diagnostic mode and check the codes. Technician B suggests check for a blown fuse. Whose advice do you take?

a. Technician A
b. Technician B
c. Both Technician A and Technician B
d. Neither Technician A nor Technician B

_____ 12. What is the name of the chart would you use if your test gave you a code of 71?

a. Left Front Outlet Valve
b. Left Front Inlet Valve
c. "Pressure Reduction Fault"
d. Pinout Checks

ASSIGNMENT ANSWERS

SERVICING ANTILOCK BRAKE SYSTEMS

IV

ASSIGNMENT SHEET 1

1. d
2. b
3. b
4. c
5. b
6. c
7. b
8. c

ASSIGNMENT SHEET 2

1. d
2. a
3. c
4. a
5. c
6. a
7. c
8. c
9. a
10. d
11. d
12. d

ASSIGNMENT SHEET 3

1. c
2. b
3. b
4. d
5. c
6. c
7. b
8. b
9. d
10. d
11. b
12. c

JOB SHEET 1

Development of:
READING SKILLS
SCIENCE SKILLS
CREATIVE THINKING/PROBLEM SOLVING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, science, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  - Using standard references
  - Following written instructions

  SCIENCE

  - Investigating/applying technology

  CREATIVE THINKING/PROBLEM SOLVING

  - Transferring knowledge/training to new situations

  EMPLOYABILITY

  - Mastering a specific job task/procedure
  - Practicing good work habits/attitudes

- If students have difficulty following written instructions:

  - Discuss the possible consequences of not following instructions precisely.
  - Have them read the instructions several times, noting the key words and ideas.
  - Discuss the difference between text guidelines and service manual instructions.

- If students have difficulty investigating/applying technology:
  - Review characteristics and functions of brake systems, parts, and components.
  - Review indications for and use of various tools.
  - Review measurements which can be made and what the measurements indicate.
  - Review how other systems are related.
- If students have difficulty transferring knowledge/training to new situations:
  - Review the pertinent training. Compare the new situation to the training situation.
  - Examine ways in which training can be used in the new situation.
- If students have difficulty mastering a specific job task/procedure:
  - Emphasize the fact that practice makes a person proficient and proficiency makes a person confident.
  - Suggest they study each component of the procedure to determine which area is causing difficulty.
  - Review the entire procedure.
  - Team them with proficient students or professionals to practice the procedure.
- If students have difficulty practicing good work habits/attitudes:
  - Encourage them to become familiar with the entire procedure before they begin the work.
  - Discuss the role that good work habits and attitudes have in obtaining and retaining employment.
  - Discuss what behaviors and attitudes constitute good work habits.
  - Make sure the student knows what is expected of him or her.

JOB SHEET 2

Development of:
READING SKILLS
SCIENCE SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, science, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  - Using standard references

  - Following written instructions

  SCIENCE

  - Investigating/applying technology

  EMPLOYABILITY

  - Mastering a specific job task/procedure

- For additional suggestions on teaching basic skills, refer to suggestions for Assignment Sheet 1 and Job Sheet 1.

JOB SHEET 3

Development of:
READING SKILLS
MATHEMATICS SKILLS
SCIENCE SKILLS
CREATIVE THINKING/PROBLEM SOLVING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, mathematics, science, creative thinking/problem solving, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  - Using standard references

  - Following written instructions

MATHEMATICS

- Using English & metric measures
- Making measurements

SCIENCE

- Investigating/applying technology
- Investigating/applying physical laws

CREATIVE THINKING/PROBLEM SOLVING

- Transferring knowledge/training to new situations

EMPLOYABILITY

- Mastering a specific job task/procedure
- Practicing good work habits/attitudes

- If students have difficulty using English and metric measures:
  - Suggest that they look at a yardstick or tape that is marked in both English and metric and study the measurements until there is a concrete idea about the lengths of different units of measurement.
  - Have students convert measurements to become accustomed to their relative sizes.
  - As work progresses, have students make measurements in one, estimate the measurement in units of the other system, then convert the measurement or remeasure using the other system.
- If students have difficulty using English and metric measures or making measurements:
  - Review units of measure in the English and metric systems.
  - Determine which system is used on the available instrument and demonstrate its use.
  - Demonstrate the correct way to measure using the specific measuring instrument.

- If students have difficulty investigating/applying physical laws:
  - Review the concepts, symbols, and principles involved.
  - Demonstrate the law in a simple manner.
  - Discuss the principles involved using situations already familiar to students.
- For additional suggestions on teaching basic skills, refer to suggestions for Assignment Sheet 1 and Job Sheet 1.

JOB SHEET 4

Development of:
READING SKILLS
MATHEMATICS SKILLS
SCIENCE SKILLS
CREATIVE THINKING/PROBLEM SOLVING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, mathematics, science, creative thinking/problem solving, and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING

  - Using standard references
  - Following written instructions
  - Interpreting graphics & symbols

  MATHEMATICS

  - Using English & metric measures

  SCIENCE

  - Investigating/applying technology
  - Investigating/applying physical laws

  CREATIVE THINKING/PROBLEM SOLVING

  - Transferring knowledge/training to new situations

EMPLOYABILITY

- Mastering a specific job task/procedure
- Practicing good work habits/attitudes

- For additional suggestions on teaching basic skills, refer to suggestions for Assignment Sheet 1 and Job Sheets 1 & 3.

JOB SHEETS 5 & 6

Development of:
READING SKILLS
SCIENCE SKILLS
CREATIVE THINKING/PROBLEM SOLVING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, science, creative thinking/problem solving, and employability skills are important.
- Discuss with them the following skills which are relevant to this task:

  READING

  - Drawing conclusions
  - Using standard references
  - Following written instructions
  - Interpreting graphics & symbols

  SCIENCE

  - Investigating/applying technology

  CREATIVE THINKING/PROBLEM SOLVING

  - Transferring knowledge/training to new situations

  EMPLOYABILITY

  - Mastering a specific job task/procedure

- For additional suggestions on teaching basic skills, refer to suggestions for Assignment Sheet 1 and Job Sheet 1.

JOB SHEET 7

Development of:
READING SKILLS
SCIENCE SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, science, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  – Using standard references

  – Following written instructions

  – Interpreting graphics & symbols

  SCIENCE

  – Investigating/applying technology

  EMPLOYABILITY

  – Mastering a specific job task/procedure

- For additional suggestions on teaching basic skills, refer to suggestions for Assignment Sheet 1 and Job Sheet 1.

JOB SHEET 8

Development of:
READING SKILLS
MATHEMATICS SKILLS
SCIENCE SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, mathematics, science, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

READING

- Using standard references
- Following written instructions
- Interpreting graphics & symbols

MATHEMATICS

- Using English & metric measures
- Making measurements

SCIENCE

- Using scientific instruments (feeler gauge)
- Investigating/applying technology
- Investigating/applying physical laws

EMPLOYABILITY

- Mastering a specific job task/procedure

- If students have difficulty using scientific instruments (feeler gauge):
  - Review the correct procedure for its use.
  - Have them watch students who are proficient with the instrument.
- For additional suggestions on teaching basic skills, refer to suggestions for Assignment Sheet 1 and Job Sheets 1 & 3.

JOB SHEET 9

Development of:
READING SKILLS
MATHEMATICS SKILLS
SCIENCE SKILLS
CREATIVE THINKING/PROBLEM SOLVING SKILLS
EMPLOYABILITY SKILLS

- Introduce the assignment to the students by discussing why reading, mathematics, science, creative thinking/problem solving, and employability skills are important.

- Discuss with them the following skills which are relevant to this task:

  READING

  - Using standard references
  - Following written instructions
  - Interpreting graphics & symbols

  MATHEMATICS

  - Using English & metric measures
  - Interpreting plans and blueprints
  - Making measurements

  SCIENCE

  - Using scientific instruments (scanner, multimeter)
  - Investigating/applying technology
  - Investigating/applying physical laws

  CREATIVE THINKING/PROBLEM SOLVING

  - Identifying critical elements/issues
  - Identifying underlying causes
  - Analyzing/synthesizing information
  - Drawing conclusions

  EMPLOYABILITY

  - Mastering a specific job task/procedure

- If students have difficulty using English and metric measures or making measurements:

  - Review units of measure in the English and metric systems.
  - Determine which system is used on the available instrument and demonstrate its use.
  - Assign exercises using the pertinent units of measure.

- If students have difficulty identifying critical elements/issues:
    - Instruct them to read or examine their sources carefully, noting key words and ideas.
    - Instruct them to listen or watch carefully for clue words that suggest a critical issue is being presented.

      EXAMPLE: Instructor, "Remember, it's important to use and follow the manufacturer check charts exactly."
    - Suggest they list the questions they hope to answer.
- If students have difficulty identifying underlying causes:
    - Review the relationships between system components.
    - Review the effects of most common system malfunctions.
    - Move component-by-component or part-by-part through the system, reviewing the purpose of each component or part and asking the student to suggest the effect of part/component failure.
    - Review the use of diagnostic charts and tools.
- If students have difficulty analyzing/synthesizing information:
    - Remind them that to analyze they must break the information down into all its component parts in order to understand it.
    - Remind them that to synthesize information they should put all the component parts together in a way that makes the information usable.
- For additional suggestions on teaching basic skills, refer to suggestions for Assignment Sheet 1 and Job Sheets 1, 3, 5, & 8.

JOB SHEET 1 — SERVICING ANTILOCK BRAKE SYSTEMS — IV

OBJECTIVE 13

Perform an antilock warning light sequence test.

INTRODUCTION

When starting a vehicle with antilock brakes, a certain sequence of events take place that are computer controlled. It is the Brake Technician that interprets these events to ensure that the system is functioning properly.

On vehicles with antilock brakes, there is both a *brake warning light* and an *antilock warning light* on the instrument panel. The first step in making an antilock brake warning light sequence test is to test the brake warning light and correct any malfunctions in the regular brake system. An accurate antilock warning light test cannot be made until you are assured that the vehicle's regular brake system is working correctly.

After you are certain that the vehicle's brakes are working correctly, you can proceed with the rest of the antilock warning light sequence test. If the sequence test indicates that even one part of the antilock system fails to function, repairs must be made to return the ABS to its proper operating condition.

During testing it is helpful to remember:

- **IGNITION ON** means that the ignition key is on, but the engine is not being cranked, nor is the engine running.

- **CRANK** means that the ignition key is in the start position, but the engine has not yet started and is not running.

- **RUN** means that the ignition is on, and the engine is running.

The following procedure is for a vehicle with a Teves ABS. If you are working on a vehicle with another ABS system, use the procedure given in your service manual.

EQUIPMENT AND MATERIALS

- Vehicle with a Teves ABS
- Appropriate service manual
- Seat cover
- Appropriate brake fluid for the vehicle (if necessary)

NOTICE: PROCEDURES VARY with the vehicle. ALWAYS CHECK THE PROCEDURE IN THE VEHICLE'S SERVICE MANUAL BEFORE BEGINNING ANY SERVICE OR REPAIR.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

General Science Skills
- Investigate/apply technology

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

Test the brake warning light

1. Sit in the front seat and release the parking brake.
2. Turn on the ignition.
3. Check to see if both the antilock warning light and the brake warning light are lit.

   NOTE: Both lights may stay brightly lit for approximately 30 seconds and then go out. Commonly the antilock warning light will turn off after about 6 seconds. The brake warning light should not be lit unless the parking brake is set or the brake fluid level is low.

4. If both lights go out after 30 seconds or less, proceed to make the antilock warning light test in the next section of this job sheet.
5. If the brake light stays lit after 30 seconds, check the level of the brake fluid in the reservoir and fill to the line if necessary.

NOTICE: BRAKE FLUID can damage the paint on a vehicle. COVER THE FENDERS WHEN YOU ARE USING BRAKE FLUID AND IMMEDIATELY WIPE UP ANY SPILLS.

CAUTION: BRAKE FLUID CAN IRRITATE your skin. WEAR GLOVES WHENEVER YOU WORK AROUND BRAKE FLUID.

6. If the brake light stays lit after you have filled the reservoir, make sure the parking brake is fully released.
7. If the brake light is still lit after the parking brake is released, check the parking brake switch to see that it is adjusted properly.

   NOTE: For information on parking brake switch adjustment, consult the service manual.

8. If the parking brake switch is adjusted properly, but the brake light remains lit, disconnect the wire from the pressure differential switch.

9. If the light goes out when you disconnect the wire from the pressure differential switch, you have a pressure loss in the regular brake system that must be repaired.

10. If the brake light remains lit after you disconnect the wire, there is a short in the electrical system. This must be repaired by an Electrical Technician.

    IMPORTANT: THE ANTILOCK SYSTEM cannot be correctly tested until the regular brake system is working perfectly. DO NOT PROCEED UNTIL THE BRAKE SYSTEM IS REPAIRED.

PROCEDURE

Cognitive Activities Skills
- Transfer knowledge/training to new situations

Job Acquisition/ Development Skills
- Master specific job task/procedure

Test the antilock warning light

1. If both lights function properly, turn the key to the CRANK position and observe the brake light and the antilock light. They should both light brightly.

2. Start the engine. When the engine starts, the brake light should immediately go out, but the antilock light may stay lit for about 6 seconds.

3. Drive the vehicle above 20 mph for 5 to 10 minutes and observe the lights. Both lights should be off.

4. Stop the vehicle using normal brake pressure. Both lights should be off.

5. Let the vehicle idle for a few seconds. Both lights should stay off.

6. Turn off engine.

7. If either light is lit or lights during any of the above procedures, an antilock system problem is present.

8. Refer to the service manual to locate the proper procedures to diagnose and correct the problem(s).

9. Clean work area and return equipment and materials to proper storage or proceed to the next job sheet as directed by your instructor.

JOB SHEET 2 — SERVICING ANTILOCK BRAKE SYSTEMS — IV

OBJECTIVE 14

Discharge integral antilock brake system pressure.

INTRODUCTION

When an antilock brake system is powered up, the accumulator stores brake fluid under very high pressure. Severe eye or skin damage can occur if the system is opened while it is still under high pressure. For this reason, it is very important that this pressure in the accumulator and the rest of the system is released before bleeding the brakes or beginning any type of brake service–whether to the regular brake system or the antilock system.

Some antilock systems (Lucas–Girling SCS, all rear-wheel systems, and some Bosch ABS) do not operate under high pressure. These low pressure ABS do not require pressure discharge.

As with any service, the technician should check the appropriate service manual to locate the safety precautions and correct method of service for the system he or she is working on.

EQUIPMENT AND MATERIALS

- Vehicle with a high pressure antilock brake system
- Appropriate service manual

NOTICE: PROCEDURES VARY with the vehicle. ALWAYS CHECK THE PROCEDURE IN THE VEHICLE'S SERVICE MANUAL BEFORE BEGINNING ANY SERVICE OR REPAIR.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

1. Sit in driver's seat of the vehicle.
2. Do not turn on the ignition key.
3. Pump the brake pedal 15 to 20 times or as often as the manufacturer suggests until the antilock system pressure is discharged.

   NOTE: The pedal should be hard to push down when the pressure has been discharged.

4. Remove the key from the ignition to prevent anyone from accidentally recharging the system.

General Science Skills
- Investigate/ apply technology

Job Acquisition/ Development Skills
- Master specific job task/procedure

5. If the service manual indicates that there are more procedures to be followed before the system pressure is discharged, check with your instructor before continuing.

6. Clean work area and return equipment and materials to proper storage or proceed to the next job sheet as directed by your instructor.

SERVICING ANTILOCK BRAKE SYSTEMS

OBJECTIVE 15

Check and fill an antilock brake system master cylinder and inspect the system for leaks.

INTRODUCTION

Brake systems, including antilock brake systems, are operated by hydraulic power. For hydraulic power to work properly, there must be adequate brake fluid.

Most high pressure antilock brake systems have a specially designed master cylinder. The valving on these master cylinders is different from the valving on a regular master cylinder. The parts of the cylinder are precisely machined and built to withstand high ABS pressures. These special master cylinders cannot be repaired; if defective, they must be replaced.

When preparing to fill an antilock brake system master cylinder, you must consider the type of fluid to be used. Most manufacturers of antilock systems warn against using a silicone-based brake fluid because it is incompatible with other types of brake fluid. Antilock systems commonly have a D.O.T. 3 brake fluid filled in the system at the factory. Because antilock brake systems are so complex, it would be impossible to drain all of the original D.O.T. 3 brake fluid sufficiently allow you to use a silicone-based fluid. If a silicone-based fluid were introduced accidently, the antilock system would become clogged, and components would be damaged and have to be replaced.

One disadvantage of D.O.T. 3 brake fluid is that it picks up water that can corrode expensive antilock components. To reduce this possibility of corrosion, antilock manufacturers recommend that an antilock brake system be flushed every 25,000 to 30,000 miles. This recommendation should be followed faithfully. Corrosion damage from water in the brake fluid is the most common cause of damage to antilock components.

It is critically important that the pressure in the system be discharged before the master cylinder is checked and filled. Even though some brake fluid is used to charge the accumulator, it is difficult to know exactly how much fluid is in the accumulator; the safest method is to discharge it before filling.

EQUIPMENT AND MATERIALS

- Vehicle with antilock brakes with an external accumulator (one that is not part of a modulator)
- Appropriate service manual
- Fender covers
- One quart of D.O.T. 3 brake fluid
- Shop cloths
- Shop light or flashlight

NOTICE: PROCEDURES VARY with the vehicle. ALWAYS CHECK THE PROCEDURE IN THE VEHICLE'S SERVICE MANUAL BEFORE BEGINNING ANY SERVICE OR REPAIR.

PROCEDURE

Check and fill an antilock brake system master cylinder

WARNING: SYSTEM PRESSURE in an antilock brake system must be discharged before beginning any brake service procedure. BE SURE SYSTEM PRESSURE IS DISCHARGED AND THE KEY IS NOT IN THE IGNITION SWITCH BEFORE BEGINNING ANY SERVICE.

---

1. Raise the hood of the vehicle.

2. Install the fender covers.

NOTICE: BRAKE FLUID can damage the paint on a vehicle. COVER THE FENDERS WHEN YOU ARE USING BRAKE FLUID AND IMMEDIATELY WIPE UP ANY SPILLS.

---

3. Locate the brake master cylinder.

   NOTE: The brake master cylinder is normally found on the left side of vehicle at the firewall.

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

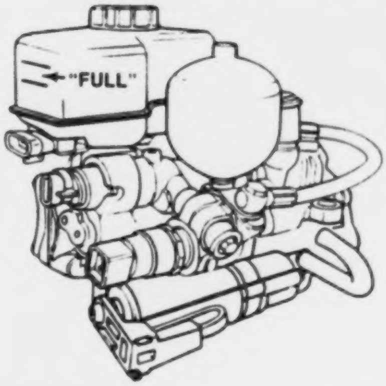
General Science Skills
- Investigate/apply technology

Physical Science Skills
- Investigate/apply physical laws

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

4. Locate the fill line on the brake fluid reservoir. (Figure 1)

FIGURE 1



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NOTE: There may be a MAX and a MIN mark on the reservoir. MAX indicates the high level (with the accumulator discharged). MIN is the lowest level (with a full accumulator). If you have trouble seeing the line, hold a light behind it; this sometimes helps to see it.

5. If the fluid level in the reservoir is at or within 1/8" of the MAX or highest line, stop and replace the cap on the master cylinder. You are finished.

6. If the level is below the MAX line by more than 1/8", add clean brake fluid until the level reaches the highest line on the reservoir.

Math Application Skills
- Use English & metric measures

Functional Math Skills
- Make measurments

CAUTION: BRAKE FLUID CAN IRRITATE your skin. WEAR GLOVES WHENEVER YOU WORK AROUND BRAKE FLUID.

---

7. Replace the cap on the brake master cylinder and the brake fluid container.

   IMPORTANT: If brake fluid is left uncapped for an extended period of time, especially during times of high humidity, the fluid pulls moisture out of the air into the fluid. If this diluted brake fluid is used in a brake system, it can cause brake fade, mushy pedal, or internal water damage to the system.

8. Sit in the driver's seat and put the key in the ignition.

9. Turn the key to the ignition ON position.

10. Listen to the pump motor–it should run for about 5 or 6 seconds and then stop.

    NOTE: The antilock warning light should stay lit as long as the pump is running.

11. If the pump does not stop after 5 or 6 seconds, turn the key off and contact the instructor. You have either a defective pump or there is an internal leak in the antilock or hydraulic system.

12. If the pump stops as it should, check the brake pedal for power assist.

PROCEDURE

Cognitive Activities Skills
- Transfer knowledge/training to new situations

Job Acquisition/ Development Skills
- Master specific job task/procedure

Inspect an antilock system for leaks

1. Use your finger to check for fluid leaks around the connections or sealing surfaces of:
   - the accumulator
   - the pump
   - the pressure switch
   - the brake lines
   - the wheel cylinders

2. If there are leaks in the accumulator, pump, or pressure switch, tighten the connections to try to stop the leak.

3. If the leaks continue, replace the seals and re-tighten the connections.

4. If there is a leak at a brake line connection, tighten the connection–there are no seals.

5. Check for leaks in the master cylinder at the point where the actuating rod attaches to the master cylinder.

6. If there is a leak in the master cylinder where the actuating rod attaches to the master cylinder, replace the master cylinder.

7. Clean work area and return equipment and materials to proper storage or proceed to the next job sheet as directed by your instructor.

JOB SHEET 4

SERVICING ANTILOCK BRAKE SYSTEMS

IV

OBJECTIVE 16

Pressure bleed an integral antilock brake system.

INTRODUCTION

Bleeding an integral antilock brake system is similar to bleeding any hydraulic brake system, with a few exceptions. The exceptions are important safety considerations that cannot be overlooked: The system must be depressurized before bleeding begins and the system should **not** be bled manually.

Antilock systems that are not high pressure systems can be bled as any standard system is bled. (See Job Sheet in Unit 1.) Antilock systems should be bled (1) if the system is opened for any reason, (2) if the brake pedal becomes mushy, or (3) if the manufacturer recommends bleeding during any testing or procedure.

Flushing the brake system is the same as bleeding, with one exception: you run more fluid through the system. The purpose of flushing is to rid the hydraulic system of any fluid-borne contaminants by completely replacing the brake fluid. Antilock manufacturers recommend frequent ABS flushing. Water in the brake fluid is the most common cause of damage to antilock systems.

EQUIPMENT AND MATERIALS

- Vehicle with a high pressure antilock brake system
- Appropriate service manual
- Fender cover
- Gloves
- Pressure brake bleeder
- Appropriate master cylinder bleeder adapter
- D.O.T. 3 brake fluid
- Appropriate bleeder wrenches
- Drip pan
- Shop cloths
- 18" to 24" length of 1/4" hose to fit the bleeder valves
- Quart jar 1/2 full of clean brake fluid
- Compressed air source
- Standard tool kit

⚠ **NOTICE:** PROCEDURES VARY with the vehicle. ALWAYS CHECK THE PROCEDURE IN THE VEHICLE'S SERVICE MANUAL BEFORE BEGINNING ANY SERVICE OR REPAIR.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

General Science Skills
- Investigate/apply technology

Cognitive Activities Skills
- Transfer knowledge/training to new situations

Job Acquisition/Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

Pressure bleed the front brakes on an antilock brake system

⚠ **WARNING:** SYSTEM PRESSURE in an antilock brake system must be discharged before beginning any brake service procedure. BE SURE SYSTEM PRESSURE IS DISCHARGED AND THE KEY IS NOT IN THE IGNITION SWITCH BEFORE BEGINNING ANY SERVICE.

---

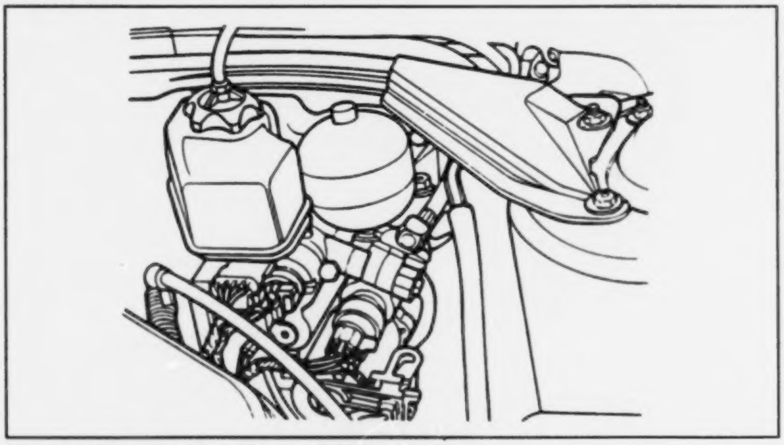
1. Raise the hood of the vehicle.
2. Install a fender cover on left front fender.

⚠ **NOTICE:** BRAKE FLUID can damage the paint on a vehicle. COVER THE FENDERS WHEN YOU ARE USING BRAKE FLUID AND IMMEDIATELY WIPE UP ANY SPILLS.

---

3. Remove the master cylinder cap or cover.
4. Find the appropriate master cylinder bleeder adapter to fit your master cylinder.
5. Install the bleeder adapter in place of the master cylinder cover, making sure that it fits snugly with no leaks. (Figure 1)

FIGURE 1



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NOTE: Your adapter may not be the same as the one pictured; use the proper adapter for your application.

6. Check to see that the pressure brake bleeder is full of the proper brake fluid.

Functional Reading Skills
- Interpret graphics & symbols

Math Application Skills
- Use English & metric measures

Physical Science Skills
- Investigate/apply physical laws

7. Attach the pressure brake bleeder to the bleeder adapter cover.

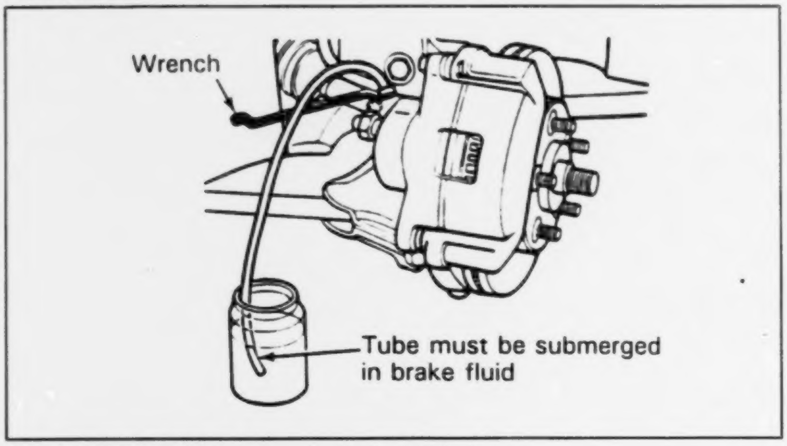
8. Connect the compressed air hose to the bleeder tank on the pressure brake bleeder.

9. Pressurize the bleeder tank with compressed air to a maximum of 20 psi.

10. Attach an 18 to 24 inch length of 1/4" hose to the bleeder valve of one front wheel cylinder.

11. Submerge the hose in a jar of clean brake fluid. (Figure 2)

FIGURE 2



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CAUTION: BRAKE FLUID CAN IRRITATE your skin. WEAR GLOVES WHENEVER YOU WORK AROUND BRAKE FLUID.

12. Open the valve on the bleeder screw with the appropriate bleeder wrench.

13. Allow the fluid to flow from the bleeder valve into the jar until no bubbles appear in the jar.

IMPORTANT: Do not allow the end of the hose to come out of the brake fluid in the jar or you will allow air into the brake system.

14. Close the bleeder valve and remove the hose.

15. Repeat steps 10 through 14 for the other front wheel.

PROCEDURE

Cognitive Activities Skills
- Transfer knowledge/training to new situations

Job Acquisition/ Development Skills
- Master specific job task/procedure

Pressure bleed the rear brakes on an antilock brake system

1. Disconnect the pressure brake bleeder from the master cylinder.

2. Check to make sure the master cylinder is full of brake fluid.

   IMPORTANT: If you remove the pressure brake bleeder in order to add brake fluid, be sure to replace the brake bleeder and repressurize the bleeder tank with compressed air before you continue.

3. Turn the ignition key to the ON position and leave it in that position while the rear brakes are being bled.

   NOTE: The pump motor should run until the accumulator is charged–about 5 or 6 seconds–and then stop. The ignition key must be left on during the bleeding of the rear brakes so the accumulator will have sufficient pressure to completely bleed the brakes.

4. Place the length of 1/4" hose on the rear wheel bleeder valve.

5. Place the other end of the hose in the jar of clean brake fluid.

6. Open the valve on the bleeder screw with the appropriate bleeder wrench.

7. Slightly depress the brake pedal for about 10 seconds, allowing the brake fluid to flow into the jar until no bubbles appear in the fluid in the jar.

   NOTE: Depressing the brake pedal allows the brake fluid to flow from the accumulator to the rear wheel cylinders.

8. Close the bleeder valve and remove the hose.

9. Check the fluid level on the master cylinder reservoir. Refill as necessary.

   IMPORTANT: If you remove the pressure brake bleeder in order to add brake fluid, be sure to replace the brake bleeder and repressurize the bleeder tank with compressed air before you continue.

10. Repeat steps 4 through 9 for the other rear wheel.

11. Turn off the ignition.

12. Depress the brake pedal and check for a good solid pedal.

13. If the pedal feels spongy, there is air in the system. Repeat all steps to re-bleed the system.

14. If the pedal feels firm when you depress it, remove the pressure bleeder adapter and replace it with the master cylinder cover.

15. Make sure all bleeder screws are snug.

NOTICE: IT IS VERY EASY to break bleeder screws. DO NOT OVERTIGHTEN BLEEDER SCREWS.

---

16. Remove the fender cover.

17. Close the hood.

18. Road test the vehicle.

19. Clean work area and return equipment and materials to proper storage or proceed to the next job sheet as directed by your instructor.

JOB SHEET 5

SERVICING ANTILOCK BRAKE SYSTEMS

IV

OBJECTIVE 17

Remove, clean, inspect, and replace wheel speed sensors.

INTRODUCTION

Wheel speed sensors are an important part of the antilock brake system. They let the controller know how fast each wheel is moving compared to the vehicle speed. The sensor and the toothed ring of the wheel speed sensor are subject to all sorts of abuse, dirt, and moisture.

If the antilock warning light is lit, wheel speed sensors could be the cause of the problem. Dirt and moisture interfere with the generator action of the sensor unit. Abuse and damage can alter the distance between the sensor and the toothed ring, interfering with their generator function. Other defects can cause the antilock warning light to come on or a code to be registered for a wheel sensor. Bent or defective axles and loose or misadjusted wheel bearings can interrupt the wheel sensor signal. You should check these components particularly well if the antilock light comes on while the vehicle is moving.

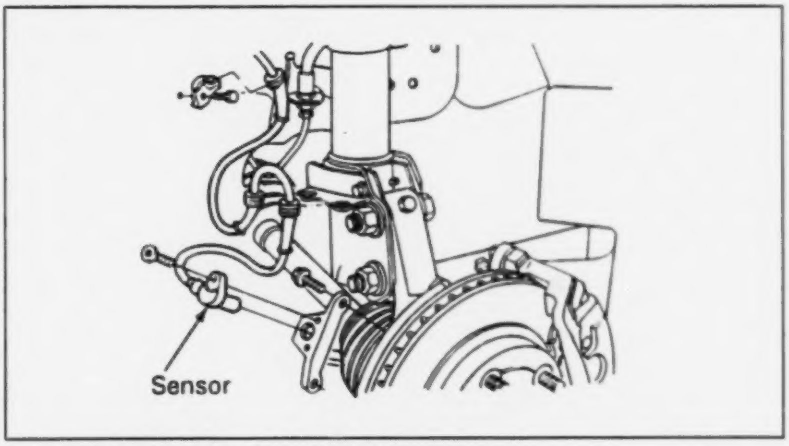
The procedures in this job sheet should be done in order to rule out wheel speed sensors as a cause of antilock problems. The wheel sensors should also be inspected and cleaned as a part of routine brake service to vehicles with antilock brakes.

Because of the many different types of wheel speed sensors and the many type of brakes, it is very important that you follow the manufacturer's procedures in performing this Job Sheet.

Functional Reading Skills

- Interpret graphics & symbols

FIGURE 1



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The following procedure is a general one that can be used with vehicles with wheel-mounted wheel speed sensors.

EQUIPMENT AND MATERIALS

- Vehicle with antilock brakes with wheel-mounted wheel speed sensors
- Appropriate service manual
- Plastic abrasive pad
- Pointed stick
- Anti-seize compound
- Standard tool kit
- Other equipment and materials as required by procedure

If it is necessary to repair the sensor cable, you will also need:

- Wire stripper
- Cable repair kit
- Heat gun
- Solder gun (if necessary)

NOTICE: PROCEDURES VARY with the vehicle. ALWAYS CHECK THE PROCEDURE IN THE VEHICLE'S SERVICE MANUAL BEFORE BEGINNING ANY SERVICE OR REPAIR.

PROCEDURE

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions

Remove wheel speed sensors

NOTE: Refer to the appropriate service manual for make and model as equipped.

WARNING: SYSTEM PRESSURE in an antilock brake system must be discharged before beginning any brake service procedure. BE SURE SYSTEM PRESSURE IS DISCHARGED AND THE KEY IS NOT IN THE IGNITION SWITCH BEFORE BEGINNING ANY SERVICE.

PROCEDURE

General Science Skills
- Investigate/apply technology

Inspect and clean wheel speed sensors

1. Use a plastic abrasive cleaning pad to clean any dirt or corrosion from the metal surface of the sensor.

NOTICE: USING STEEL WOOL or any other type of metal cleaning device may damage the sensor. USE ONLY A PLASTIC ABRASIVE PAD TO CLEAN THE SENSOR.

Job Acquisition Development Skills
- Master specific job task/procedure

2. Use a pointed stick to clean dirt or mud from the notches on the toothed ring.

3. Use the plastic abrasive pad to clean the surface of the teeth on the toothed ring.

   NOTE: The best method is to hold the pad against the teeth and rotate the axle.

Cognitive Activities Skills
- Draw conclusions

4. Inspect the teeth of the toothed ring for any chips or broken teeth. If any are found, you must replace the toothed ring.

   NOTE: Some toothed rings are part of the hub, drum, rotor, or axle. When this is the case, the entire hub, drum, rotor, or axle must be replaced if the toothed ring is damaged.

5. Check to see that the toothed ring is still magnetized by placing a small screwdriver against it and feeling for a slight drag.

   NOTE: If the toothed ring has lost its magnetism, it must be replaced.

6. Check the magnetic sensor for chips at the edge of the metal cover.

   NOTE: If any are found, you must replace the sensor.

7. Check the magnetism of the sensor using the same method as for the toothed ring. If the sensor has lost its magnetism, it must be replaced.

8. Coat each part of the wheel speed sensor with a light film of anti-seize compound.

PROCEDURE

Inspect and repair a wheel sensor cable

Job Acquisition/ Development Skills
- Master specific job task/procedure

1. Inspect the sensor cable for broken wires, frayed areas, damaged outer sleeve, or chafing.

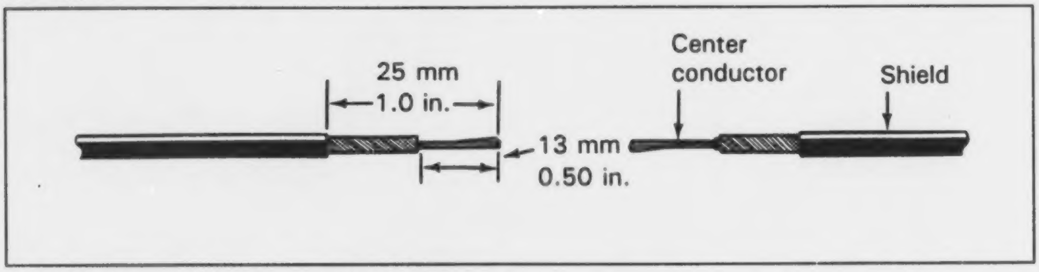
2. If any of the above are found, you must repair the cable.

   NOTE: If 3 or more inches of wire is damaged, you will probably have to replace the entire cable.

3. Obtain a cable repair kit which consists of (1) a black outer sleeve, (2) a center conductor insulator, (3) a soldershield, and (4) a center sleeve.

4. If there are damaged wires, strip the two cable ends. (Figure 2)

FIGURE 2


25 mm
1.0 in.
13 mm
0.50 in.
Center conductor
Shield

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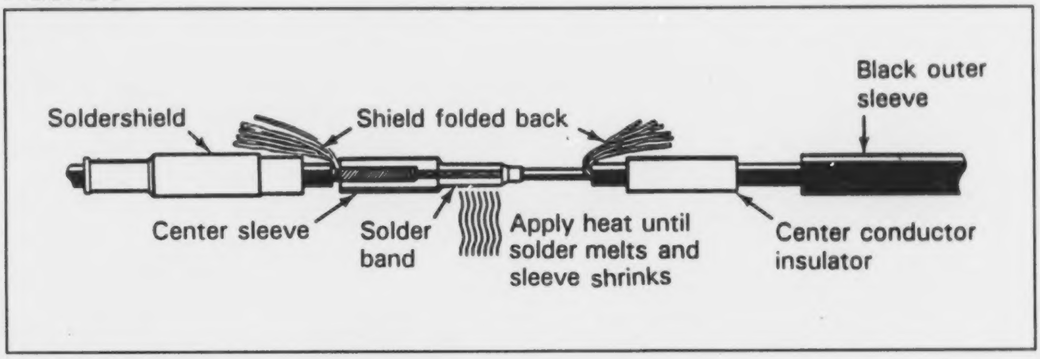
5. Install the kit parts listed in step 3. (Figure 3)

FIGURE 3


Black outer sleeve
Soldershield
Shield folded back
Center sleeve
Solder band
Apply heat until solder melts and sleeve shrinks
Center conductor insulator

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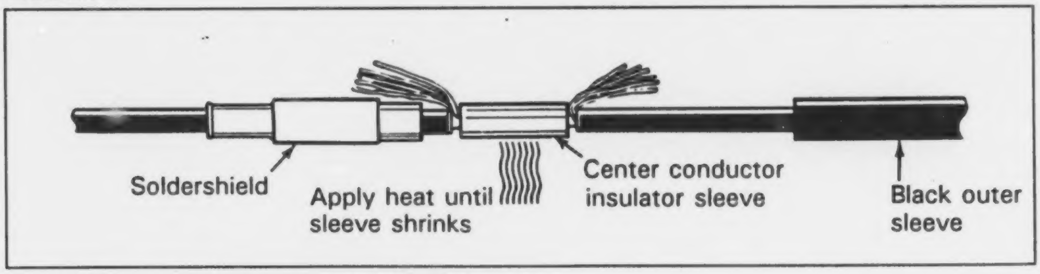
6. Use a heat gun to heat the center sleeve.

7. Slide the center conductor insulator in place and heat it until it shrinks. (Figure 4)

FIGURE 4


Soldershield
Apply heat until sleeve shrinks
Center conductor insulator sleeve
Black outer sleeve

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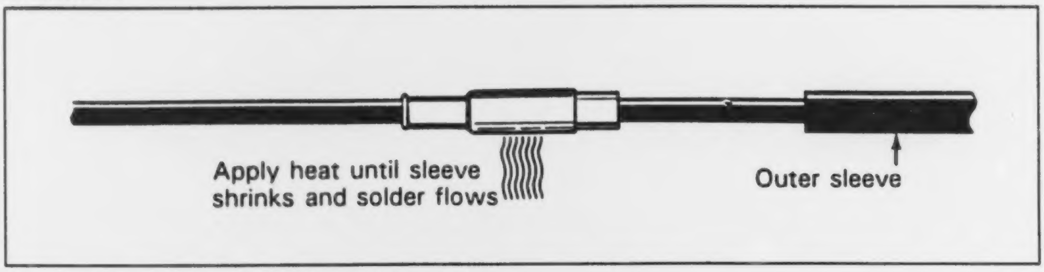
8. Move the cable shield over the center conductor insulator and slide the soldershield in place. (Figure 5)

FIGURE 5


Apply heat until sleeve shrinks and solder flows
Outer sleeve

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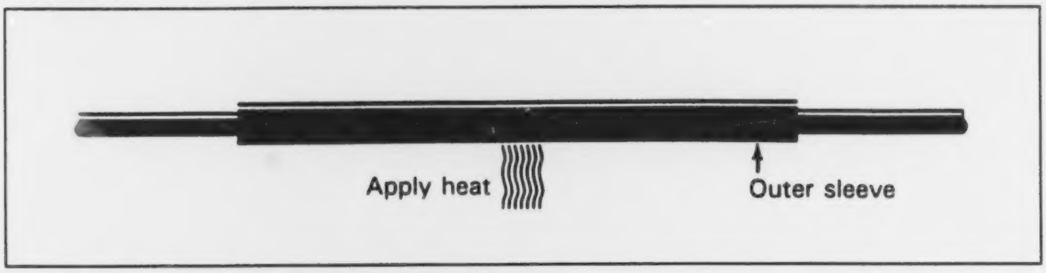
9. Heat the soldershield with a heat gun or a soldering iron until the solder melts and the sleeve shrinks.
10. Slide the black outer sleeve over the repaired area and heat it with a heat gun until it shrinks. (Figure 6)

FIGURE 6


Apply heat
Outer sleeve

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PROCEDURE

Job Acquisition/
Development Skills

- Master specific job task/procedure

Replace wheel speed sensors

NOTE: Refer to the appropriate service manual for the proper installation and adjustment based on the type and style of sensor used.

JOB SHEET 6 — SERVICING ANTILOCK BRAKE SYSTEMS

OBJECTIVE 18

Perform a pressure diagnosis on an integral antilock system fluid pressurization system.

INTRODUCTION

Most antilock brake systems are under extremely high pressure and because of this, even a small internal leak can cause serious pressure loss. Pressure diagnosis can tell the technician (1) whether or not there is a leak in the system, (2) if the pressure in the accumulator is at the correct level for proper functioning, and (3) if accumulator pressure is being maintained at a constant operating level.

If the pump runs for more than 6 seconds when the ignition is turned on, this could be a sign that there is a problem with accumulator pressure. Often a pressure diagnosis is one of the first tests manufacturers recommend. Accumulators are replaceable and testing and replacing one is simple compared to some of the other tests and service that may need to be performed.

Many of the antilock tests that are made are similar to standard hydraulic brake pressure tests, except pressures in antilock systems are much higher and connections are located differently. If pressure is low or does not operate at a constant level, the service manual will direct you to additional tests to diagnose the problem. No pressure tests are listed for the Bendix ABS (used mostly by Chrysler) or the Lucas-Girling SCS. These are low-pressure systems.

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics & symbols

General Science Skills
- Investigate/apply technology

EQUIPMENT AND MATERIALS

- Vehicle with a high pressure antilock brake system
- Appropriate service manual
- Other equipment and materials as required by procedure

PROCEDURE

NOTE: Refer to the appropriate service manual for make and model as equipped.

Cognitive Activities Skills
- Draw conclusions

Job Acquisition/Development Skills
- Master specific job task/procedure

JOB SHEET 7

SERVICING ANTILOCK BRAKE SYSTEMS

IV

OBJECTIVE 19

Remove and install hydraulic antilock brake system components.

INTRODUCTION

Corrosion from water-bearing brake fluid is the major cause of damage to antilock hydraulic components. Before they are removed and replaced, the Brake Technician must use a scanner to test the system. It is important that the scanner and/or scanner cartridge recommended by the antilock manufacturer be used to perform these tests. The manual that accompanies the scanner will give you the correct procedures to be followed.

The major components of an antilock hydraulic system are the master cylinder and reservoir, pump and motor, pressure switch, accumulator, and solenoid valve body. (See Figure 1 on the next page.) Components on high pressure systems must be replaced rather than repaired if they are defective. The solenoid valve body and the master cylinder are usually replaced together; both are replaced, even if only one is defective. On most systems, the reservoir, pressure switch, accumulator, and pump and motor, can be replaced individually.

Except for the modulator, hydraulic components on low pressure antilock brake systems are usually identical with the components on standard brake systems; these components can be rebuilt as necessary. Because there are so many different types of antilock systems, you must refer to the service manual for the vehicle you are using to give you the appropriate procedures for removing and installing antilock hydraulic components.

The routine safety precaution of using safety glasses or goggles while in the shop is particularly important when performing this Job Sheet.

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics & symbols

General Science Skills
- Investigate/apply technology

Job Acquisition/ Development Skills
- Master specific job task/procedure

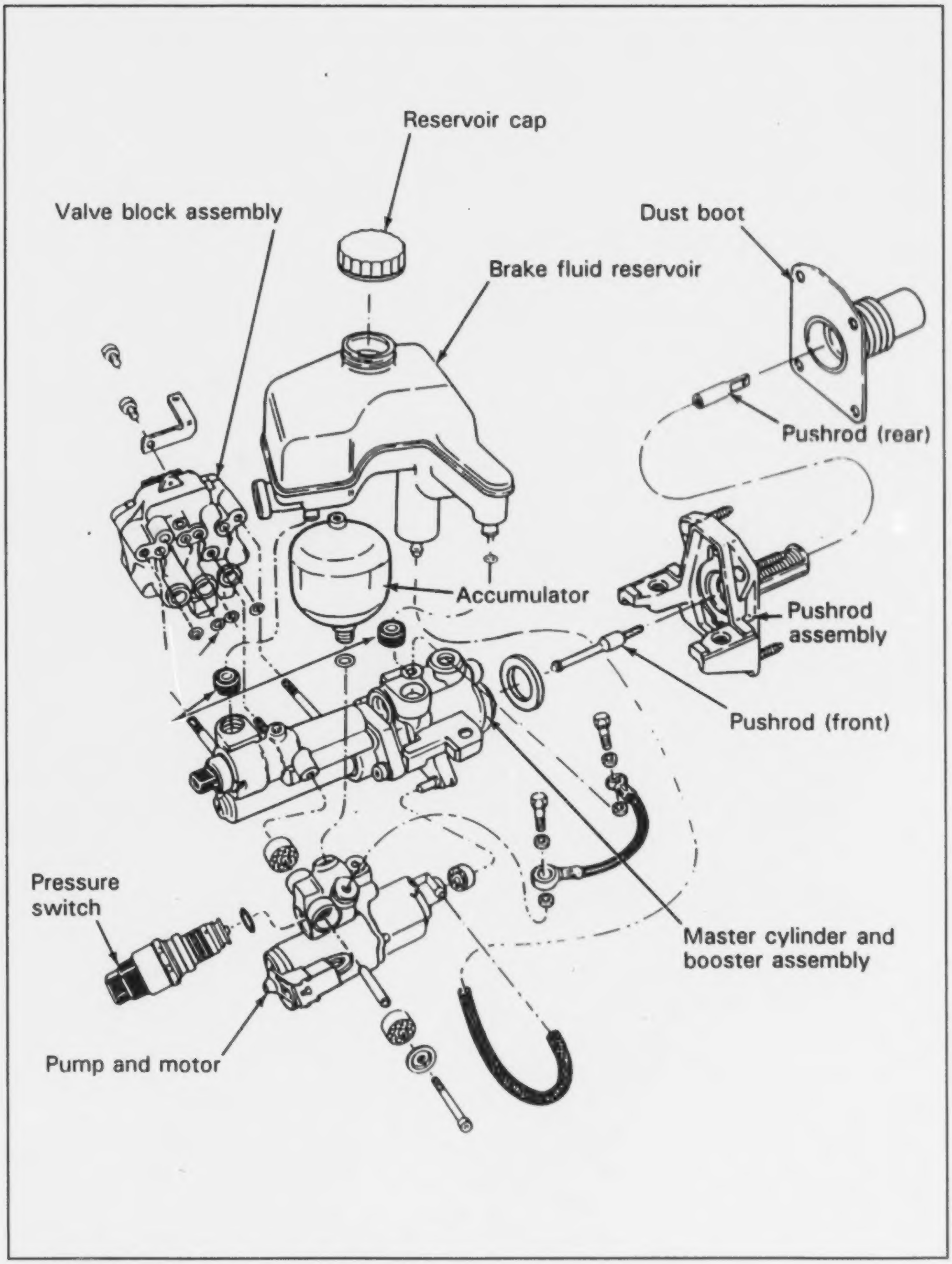
EQUIPMENT AND MATERIALS

- Vehicle with a high pressure antilock brake system
- Appropriate service manual
- Other equipment and materials as required by procedure

PROCEDURE

NOTE: Refer to the appropriate service manual for make and model as equipped.

(An illustration of antilock hydraulic components is on the next page.)


Reservoir cap
Valve block assembly
Dust boot
Brake fluid reservoir
Pushrod (rear)
Accumulator
Pushrod assembly
Pushrod (front)
Pressure switch
Master cylinder and booster assembly
Pump and motor

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JOB SHEET 8

SERVICING ANTILOCK BRAKE SYSTEMS

IV

OBJECTIVE 20

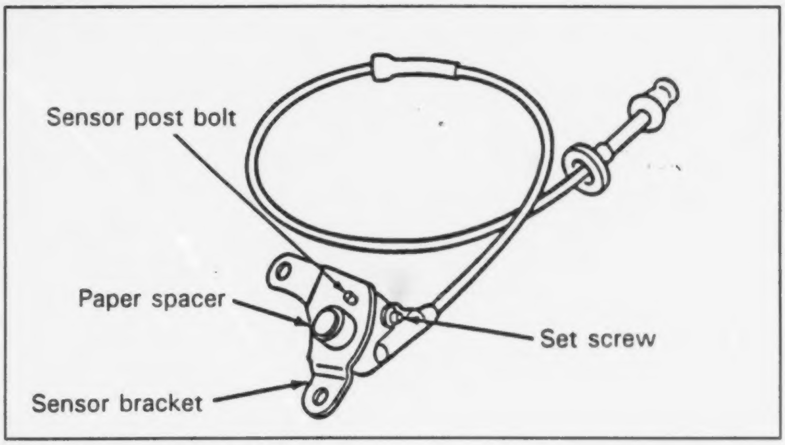
Measure wheel speed sensor air gaps.

INTRODUCTION

Wheel speed sensors are similar to small A/C generators. As the magnetic fields of the sensor and the toothed ring pass close to each other, a small voltage is induced into the sensor. This voltage signal is read by the controller to determine wheel speed.
In order to produce this signal properly, the distance (or *air gap*) between the sensor and the teeth of the toothed ring must meet the manufacturer's recommended specification. If the sensor and the ring are too close together, the signal frequency becomes distorted. If they are too far apart, no voltage signal will be sent. Wheel speed sensor air gaps should be measured and adjusted whenever the wheel speed sensor is moved for any reason and should also be checked as part of regular brake ABS service.

Some sensors cannot be adjusted. They are installed in a special bracket that provides the proper spacing. Other sensors have a piece of paper attached to the face of the sensor and the thickness of the paper is the proper gap. When the sensor is installed against the toothed ring and the toothed ring turns, the paper comes off, leaving the proper air gap. (Figure 1)

FIGURE 1



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Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics & symbols

Math Application Skills
- Use English & metric measures

Functional Math Skills
- Make measurements

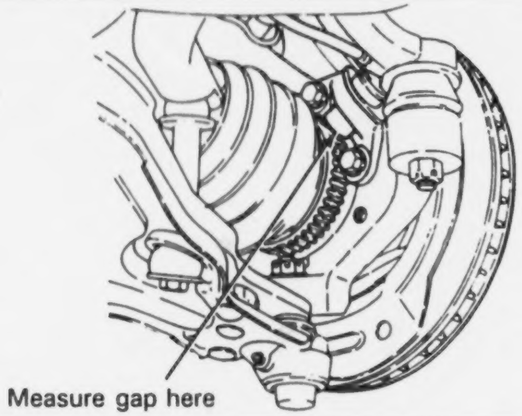
General Science Skills
- Use scientific instruments (feeler gauge)
- Investigate/apply technology

Physical Science Skills
- Investigate/apply physical laws

Job Acquisition/ Development Skills
- Master specific job task/procedure

For wheel speed sensors that do require adjustment, it is important that you use a feeler gauge made of brass, plastic, or some other material that is not affected by magnetism. If a feeler gauge that can be influenced by magnetism is used, the magnetic nature of the sensor and wheeled tooth will cause an incorrect measurement. (Figure 2)

FIGURE 2



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EQUIPMENT AND MATERIALS

- Vehicle with antilock brakes with wheel-mounted wheel speed sensors
- Appropriate service manual
- Other equipment and materials as required by procedure

PROCEDURE

NOTE: Refer to the appropriate service manual for make and model as equipped.

JOB SHEET 9 — SERVICING ANTILOCK BRAKE SYSTEMS

IV

OBJECTIVE 21

Perform an individual wheel speed sensor pin test.

INTRODUCTION

Making a wheel speed sensor pin test involves checking the voltage and continuity of the electrical impulse being transmitted through the wiring between the wheel speed sensor and the controller. The test is made with either a scanner or a multimeter. If you use a multimeter, it is desirable to use a breakout box with it because it saves time and eliminates the possibility of damaging the sensor with the probe on the multimeter. However, a digital multimeter must be used–with or without the breakout box. An analog (dial-type) multimeter should not be used because it will draw more current than the ABS system can handle and will damage the controller.

If you must test the wheel speed sensors without a breakout box, you should disconnect the wheel sensors at the harness connections. A *pin* is the part of a connector that joints two wiring harnesses together. Using the manufacturer's schematic (similar to the one shown in Figure 1 on a following page), you can determine the pin numbers that need to be checked.

Many manufacturers provide the technician with check charts that must be followed in order to properly check wheel speed sensors components. See the sample chart shown in Figure 2 on a following page. Do not use any short cuts–follow the manufacturer's charts. If you do not, you will come to the wrong conclusions in your testing.

Once the pin tests have been made, the service manual will direct you to other scanner or diagnostic tests to trace the source of the problem.

Research and Reference Skills
- Use standard references

Functional Reading Skills
- Follow written instructions
- Interpret graphics & symbols

Math Application Skills
- Use English & metric measures

Data Analysis and Display Skills
- Interpret plans/blueprints

Functional Math Skills
- Make measurements

EQUIPMENT AND MATERIALS

- Vehicle with antilock brakes with wheel-mounted wheel speed sensors
- Appropriate service manual
- Other equipment and materials as required by procedure

PROCEDURE

NOTE: Refer to the appropriate service manual for make and model as equipped.

General Science Skills

- Use scientific instruments (scanner or multimeter)
- Investigate/apply technology

Physical Science Skills

- Investigate/apply physical laws

Cognitive Activities Skills

- Identify critical elements/issues
- Identify underlying causes
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development Skills

- Master specific job task/procedure

FIGURE 2

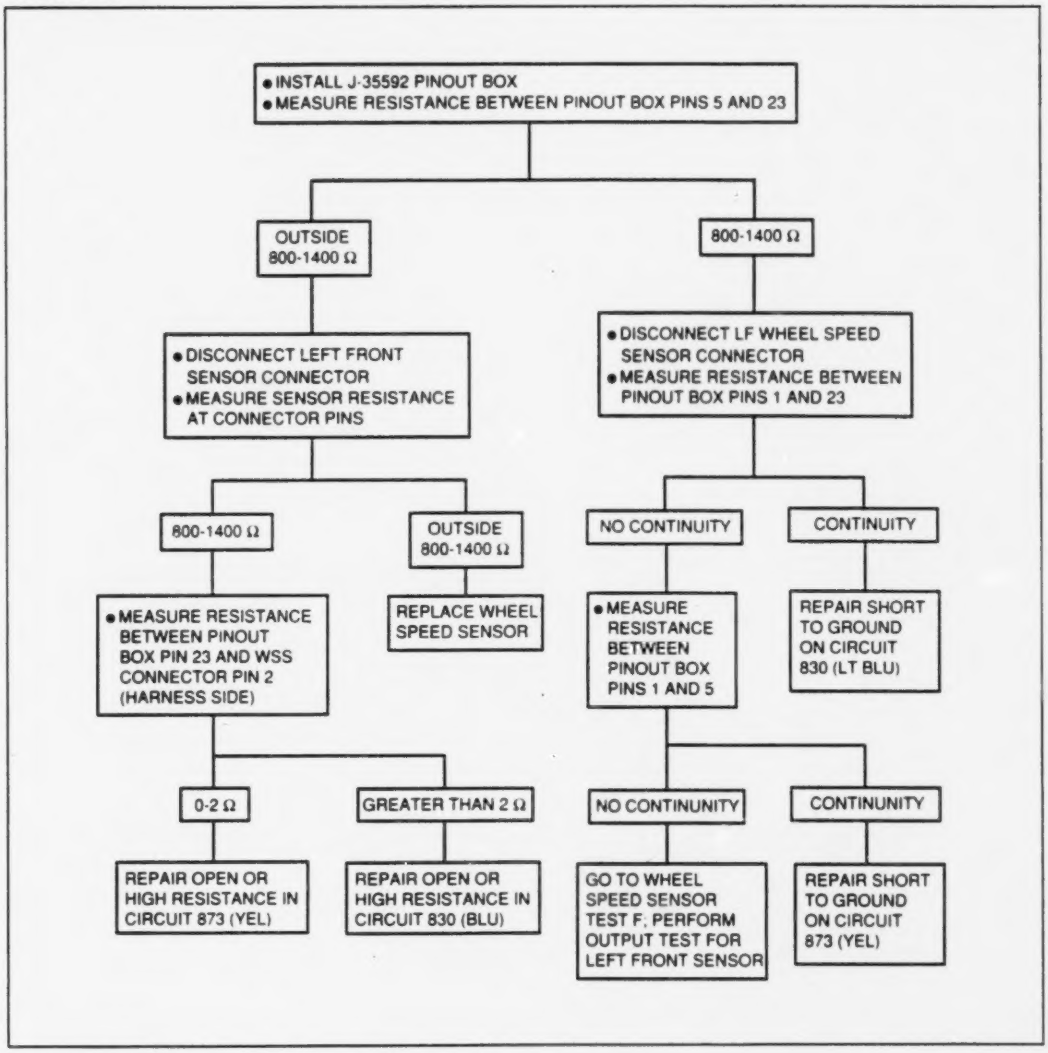
• INSTALL J-35592 PINOUT BOX
• MEASURE RESISTANCE BETWEEN PINOUT BOX PINS 5 AND 23
OUTSIDE 800-1400 Ω
800-1400 Ω
• DISCONNECT LEFT FRONT SENSOR CONNECTOR
• MEASURE SENSOR RESISTANCE AT CONNECTOR PINS
• DISCONNECT LF WHEEL SPEED SENSOR CONNECTOR
• MEASURE RESISTANCE BETWEEN PINOUT BOX PINS 1 AND 23
800-1400 Ω
OUTSIDE 800-1400 Ω
NO CONTINUITY
CONTINUITY
• MEASURE RESISTANCE BETWEEN PINOUT BOX PIN 23 AND WSS CONNECTOR PIN 2 (HARNESS SIDE)
REPLACE WHEEL SPEED SENSOR
• MEASURE RESISTANCE BETWEEN PINOUT BOX PINS 1 AND 5
REPAIR SHORT TO GROUND ON CIRCUIT 830 (LT BLU)
0-2 Ω
GREATER THAN 2 Ω
NO CONTINUNITY
CONTINUNITY
REPAIR OPEN OR HIGH RESISTANCE IN CIRCUIT 873 (YEL)
REPAIR OPEN OR HIGH RESISTANCE IN CIRCUIT 830 (BLU)
GO TO WHEEL SPEED SENSOR TEST F; PERFORM OUTPUT TEST FOR LEFT FRONT SENSOR
REPAIR SHORT TO GROUND ON CIRCUIT 873 (YEL)

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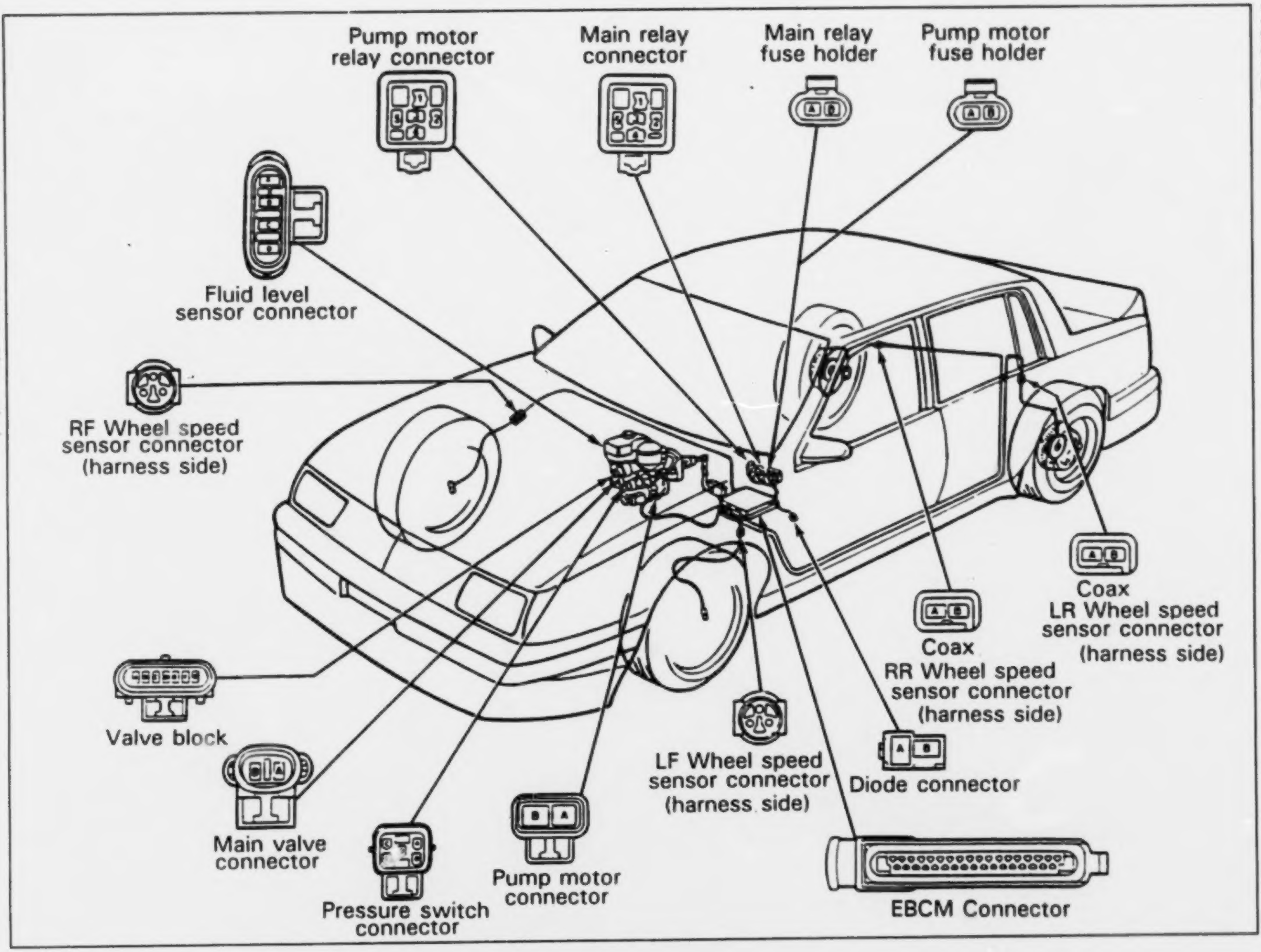
FIGURE 1


Pump motor relay connector
Main relay connector
Main relay fuse holder
Pump motor fuse holder
Fluid level sensor connector
RF Wheel speed sensor connector (harness side)
Coax
LR Wheel speed sensor connector (harness side)
Coax
RR Wheel speed sensor connector (harness side)
Valve block
LF Wheel speed sensor connector (harness side)
Diode connector
Main valve connector
Pressure switch connector
Pump motor connector
EBCM Connector

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SERVICING ANTILOCK BRAKES SYSTEMS

JOB SHEET 1

Perform an antilock warning light sequence test.

Student's name ______________________ Date ____________

Evaluator's name ______________________ Attempt no. ______

Instructions: When you are ready to perform this task ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Tested the brake warning light following outlined procedures.	___	___
3. Tested the antilock warning light following outlined procedures.	___	___
4. Referred to service manually to diagnose warning light problems.	___	___
5. Observed safety rules and precautions.	___	___
6. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training

3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required

2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill

1 **Unskilled** – Is familiar with process, but is unable to perform job

PRACTICAL TEST 2

SERVICING ANTILOCK BRAKES SYSTEMS

IV

JOB SHEET 2

Discharge integral antilock brake system pressure.

Student's name ______________________ Date ____________

Evaluator's name ______________________ Attempt no. ______

Instructions: When you are ready to perform this task ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Pumped brake pedal the number of times the manufacturer suggested until the brake pedal became hard.	___	___
3. Removed key from ignition before performing further tests.	___	___
4. Observed safety rules and precautions.	___	___
5. Checked with instructor for further instructions if necessary.	___	___
6. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training
3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required
2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill
1 **Unskilled** – Is familiar with process, but is unable to perform job

PRACTICAL TEST 3

SERVICING ANTILOCK BRAKES SYSTEMS

IV

JOB SHEET 3

Check and fill an antilock brake system master cylinder and inspect the system for leaks.

Student's name ____________________ Date __________

Evaluator's name ____________________ Attempt no. _____

Instructions: When you are ready to perform this task ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Prepared the vehicle and work area appropriately.	___	___
3. Checked the reservoir level correctly.	___	___
4. Filled the reservoir following outlined procedures.	___	___
5. Recharged the system pressure correctly.	___	___
6. Inspected for leaks following outlined procedures.	___	___
7. Located and corrected leaks correctly.	___	___
8. Observed safety rules and precautions	___	___
9. Cleaned work area and returned materials and equipment to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training
3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required
2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill
1 **Unskilled** – Is familiar with process, but is unable to perform job

PRACTICAL TEST 4

SERVICING ANTILOCK BRAKES SYSTEMS

IV

JOB SHEET 4

Pressure bleed an integral antilock brake system.

Student's name ____________________ Date __________

Evaluator's name ____________________ Attempt no. _____

Instructions: When you are ready to perform this task ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Prepared the vehicle and work area appropriately.	___	___
3. Installed bleeder equipment properly.	___	___
4. Pressurized bleeder unit to correct pressure.	___	___
5. Bled front brakes following outlined procedures.	___	___
6. Bled rear brakes following outlined procedures.	___	___
7. Completed service correctly.	___	___
8. Observed safety rules and precautions	___	___
9. Cleaned work area and returned materials and equipment to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training
3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required
2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill
1 **Unskilled** – Is familiar with process, but is unable to perform job

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PRACTICAL TEST 5

SERVICING ANTILOCK BRAKES SYSTEMS

JOB SHEET 5

Remove, clean, inspect, and replace wheel speed sensors.

Student's name ______________________ Date ____________

Evaluator's name ______________________ Attempt no. ______

Instructions: When you are ready to perform this task ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Prepared the vehicle and work area appropriately.	___	___
3. Removed wheel sensors following manufacturer's instructions.	___	___
4. Inspected wheel sensors according to outlined procedure.	___	___
5. Cleaned wheel sensors according to procedure.	___	___
6. Repaired wheel sensor cable following outlined procedures.	___	___
7. Replaced wheel sensors following manufacturer's procedure.	___	___
8. Completed service correctly.	___	___
9. Observed safety rules and precautions.	___	___
10. Cleaned work area and returned materials and equipment to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training
3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required
2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill
1 **Unskilled** – Is familiar with process, but is unable to perform job

PRACTICAL TEST 6 | SERVICING ANTILOCK BRAKES SYSTEMS | IV

JOB SHEET 6

Perform a pressure diagnosis on an integral antilock system fluid pressurization system.

Student's name ____________________ Date __________

Evaluator's name ____________________ Attempt no. _____

Instructions: When you are ready to perform this task ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Checked vehicle service manual for proper procedure.	___	___
3. Performed all pressure tests according to manufacturer's instructions and specifications.	___	___
4. Completed service correctly.	___	___
5. Observed safety rules and precautions.	___	___
6. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training
3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required
2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill
1 **Unskilled** – Is familiar with process, but is unable to perform job

PRACTICAL TEST 7

SERVICING ANTILOCK BRAKES SYSTEMS

IV

JOB SHEET 7

Remove and install hydraulic antilock brake system components.

Student's name ______________________ Date ____________

Evaluator's name ______________________ Attempt no. ______

Instructions: When you are ready to perform this task ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Prepared the vehicle and work area appropriately.	___	___
3. Removed components correctly following manufacturer's instructions.	___	___
4. Replaced components following manufacturer's instructions.	___	___
5. Completed service correctly.	___	___
6. Observed safety rules and precautions.	___	___
7. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training
3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required
2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill
1 **Unskilled** – Is familiar with process, but is unable to perform job

SERVICING ANTILOCK BRAKES SYSTEMS

JOB SHEET 8

Measure wheel speed sensor air gaps.

Student's name ______________________ Date ___________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Prepared the vehicle and work area appropriately.	___	___
3. Measured air gap properly according to manufacturer's specifications.	___	___
4. Observed safety rules and precautions.	___	___
5. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

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AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training
3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required
2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill
1 **Unskilled** – Is familiar with process, but is unable to perform job

PRACTICAL TEST 9

SERVICING ANTILOCK BRAKES SYSTEMS

IV

JOB SHEET 9

Perform an individual wheel speed sensor pin test.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	Yes	No
1. Obtained proper equipment and materials.	___	___
2. Prepared the vehicle and work area appropriately.	___	___
3. Correctly identified the correct service manual procedures to be followed.	___	___
4. Installed the test equipment correctly.	___	___
5. Followed the manufacturer's testing procedures accurately.	___	___
6. Reconnected all components properly.	___	___
7. Observed safety rules and precautions.	___	___
8. Cleaned work area and returned equipment and materials to proper storage.	___	___

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training
3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required
2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill
1 **Unskilled** – Is familiar with process, but is unable to perform job

SERVICING ANTILOCK BRAKE SYSTEMS

Name ______________________ Score ________

OBJECTIVE 1

Define terms associated with antilock brake systems by selecting the correct definition from four choices. Place the letter of the correct definition in the blank.

_____ 1. **ABS – antilock brake system**

a. A brake system used on trailers designed to stop when disconnected
b. A brake system which locks the wheels to prevent theft of the vehicle
c. A brake system designed to prevent skidding when the brakes are applied on slick or loose surfaces
d. A brake system designed to reduce wheel lock when accelerating

_____ 2. **solenoid**

a. An electromagnetic control device which is commonly used to open or close an electrical circuit
b. A valve which opens to allow brake fluid to enter the modulator
c. An antilock component which stores brake fluid for use during antilock operation
d. A screw valve on the wheel cylinder used to bleed the brakes

_____ 3. **probe**

a. A plastic tube inserted into the accumulator that controls the flow of brake fluid during antilock operation
b. A sensor used to control modulator operation
c. To insert the metal tip of a test instrument into the wiring of an electrical circuit in order to test it
d. An electromagnetic control device which is commonly used to open or close an electrical circuit

May be photocopied for student use.

______ 4. **lockup**

a. Condition in which the steering wheel will not move when the ignition key is removed
b. The point when a vehicle's tires have stopped rotating, even though the momentum of the vehicle keeps the vehicle moving
c. The point at which tire traction overcomes braking power
d. Condition in which the brake shoes will not retract

______ 5. **breakout box**

a. Testing equipment for the brake hydraulic system
b. A specialized piece of ABS testing equipment that allows the voltage and/or continuity to be tested without probing the wiring of the antilock system
c. A device that is used to repair the ABS wiring harness
d. A special ABS testing device that is used to check the codes on an ABS

______ 6. **skid**

a. The action of the brakes on a moving vehicle
b. The action that occurs when a vehicle's momentum keeps the vehicle moving even though its wheels are not turning
c. The action that occurs when a vehicle's momentum eventually stops the vehicle
d. The point at which tire traction overcomes braking power

______ 7. **Integrate**

a. To change the function of a component from one vehicle to another
b. To separate one unit into several different components
c. To eliminate a component from a system
d. To combine several independent components into a single unit

May be photocopied for student use.

_____ 8. **driveshaft**

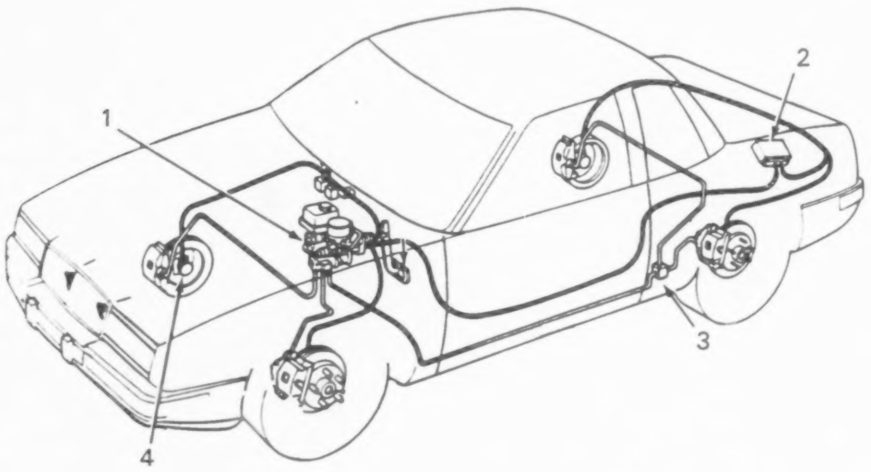
a. The shaft that opens and closes the accumulator in an antilock system
b. The part of the driveline that transfers the engine's turning power from the transmission to the differential
c. The shaft in the brake master cylinder that keeps pressure on the hydraulic fluid to operate the brakes
d. The shaft in the differential that transfers the engine's turning power from the driveline to the differential

_____ 9. **drive pinion gear**

a. The gear in the differential that transfers the engine's turning power from the driveline to the differential
b. The gear in the solenoid valve body that accepts turning power from the transmission
c. The part of the drive gear that transfers the engine's turning power from the transmission to the driveline
d. A driveshaft gear that acts on the antilock controller

May be photocopied for student use.

OBJECTIVE 2 **Match the names of the parts of a four-wheel antilock brake system to an illustration.** Place the letter of the correct part in the blank. Answers may be used once, more than once, or not at all.



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______ 1.
______ 2.
______ 3.
______ 4.

a. accumulator
b. antilock warning light
c. controller
d. hydraulic unit
e. modulator
f. pressure switch
g. proportioning valve
h. pump and motor
i. solenoid valve body
j. wheel speed sensor

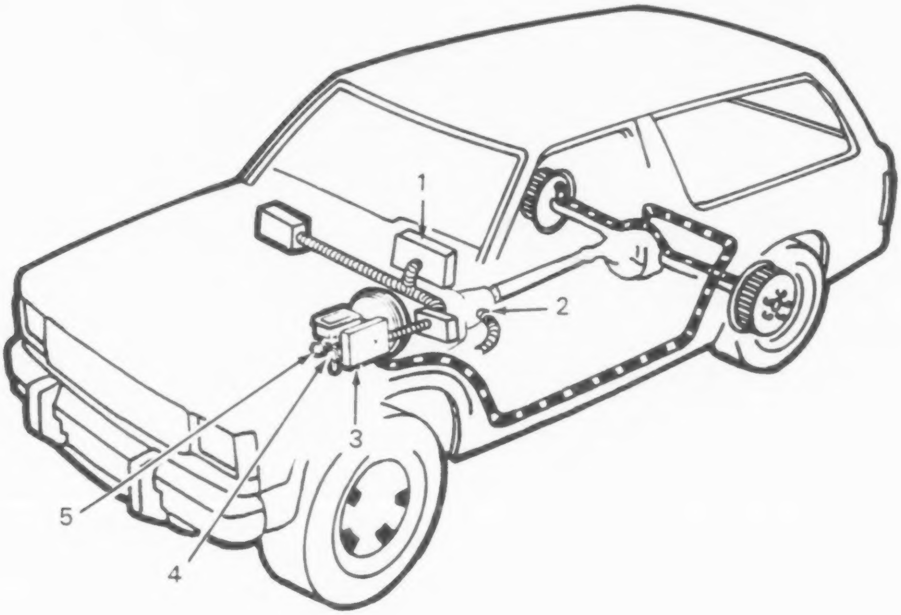
5. Which of the parts listed on the right are part of the hydraulic unit in this illustration? (Put the letters of the correct parts.)

____

May be photocopied for student use.

OBJECTIVE 3

Match the names of the parts of a rear-wheel antilock brake system to an illustration. Place the letter of the correct part in the blank. Answers may be used once, more than once, or not at all.



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______ 1.	a. accumulator
______ 2.	b. antilock warning light
______ 3.	c. controller
______ 4.	d. hydraulic unit
______ 5.	e. modulator
	f. pressure switch
	g. proportioning valve
	h. pump and motor
	i. solenoid valve body
	j. speed sensor

OBJECTIVE 4

Match the names of the components of an antilock brake system to descriptions of their functions.

_____ 1. Pressurizes the brake fluid used in the antilock brake system

_____ 2. Stores high pressure brake fluid during antilock operation

_____ 3. Signals the driver that the antilock system is not working

_____ 4. Monitors individual wheel speed and sends this information to the controller

_____ 5. Delays hydraulic pressure to the rear wheels so they don't brake before the front wheels

_____ 6. Monitors the hydraulic pressure level of the brake system and turns the pump on and off to maintain the correct pressure

_____ 7. Contains a solenoid valve body and a small accumulator, combining the functions of both

_____ 8. Receives information from the wheel speed sensors, analyzes it, and sends a signal to the solenoid valve body to pump the brakes

_____ 9. When they receive the appropriate signals from the controller, solenoids in this component pump the brakes to the appropriate wheels to prevent lockup

a. accumulator

b. antilock warning light

c. controller

d. hydraulic unit

e. modulator

f. pressure switch

g. proportioning valve

h. pump and motor

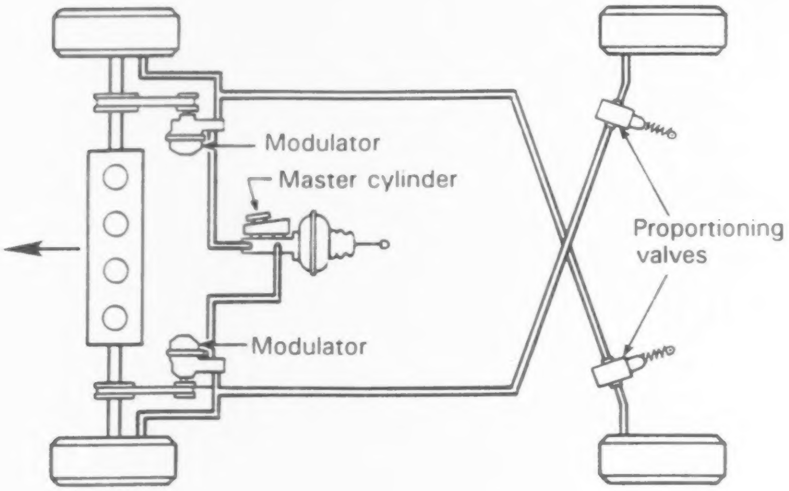
i. solenoid valve body

j. wheel speed sensors

_____ 10. An integral unit usually consisting of a master cylinder, accumulator, pressure switch, pump and motor, and solenoid valve body

OBJECTIVE 5 **Identify types of four-wheel antilock brake systems from illustrations.** Write the name of the antilock brake system shown in the space provided.

Bendix ABS	Lucas-Girling SCS
Bosch ABS 2U	Teves ABS
Delco Moraine ABS	


Modulator
Master cylinder
Proportioning valves
Modulator

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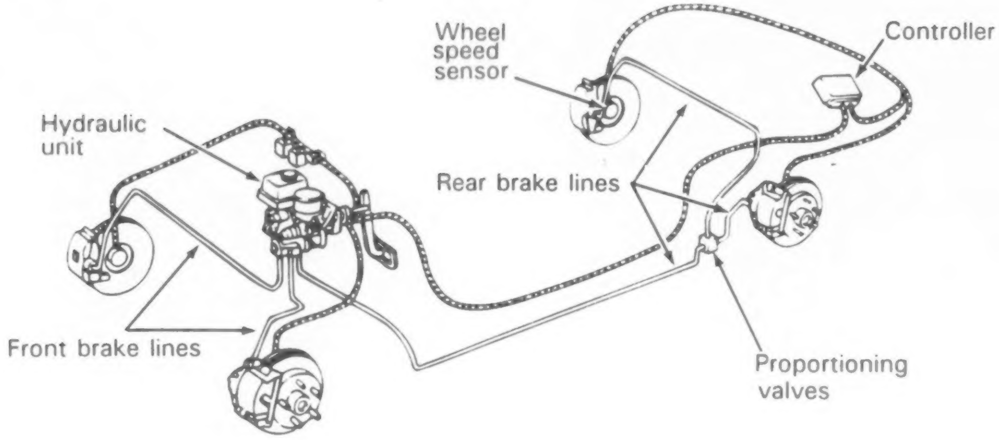
1. Type of ABS/SCS: ____________________


Wheel speed sensor
Controller
Hydraulic unit
Rear brake lines
Front brake lines
Proportioning valves

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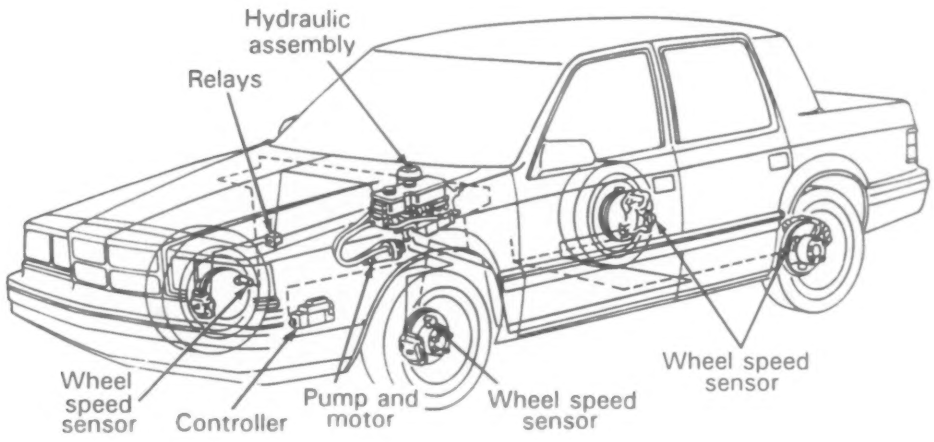
2. Type of ABS/SCS: ______________________________


Hydraulic assembly
Relays
Wheel speed sensor
Wheel speed sensor
Controller
Pump and motor
Wheel speed sensor

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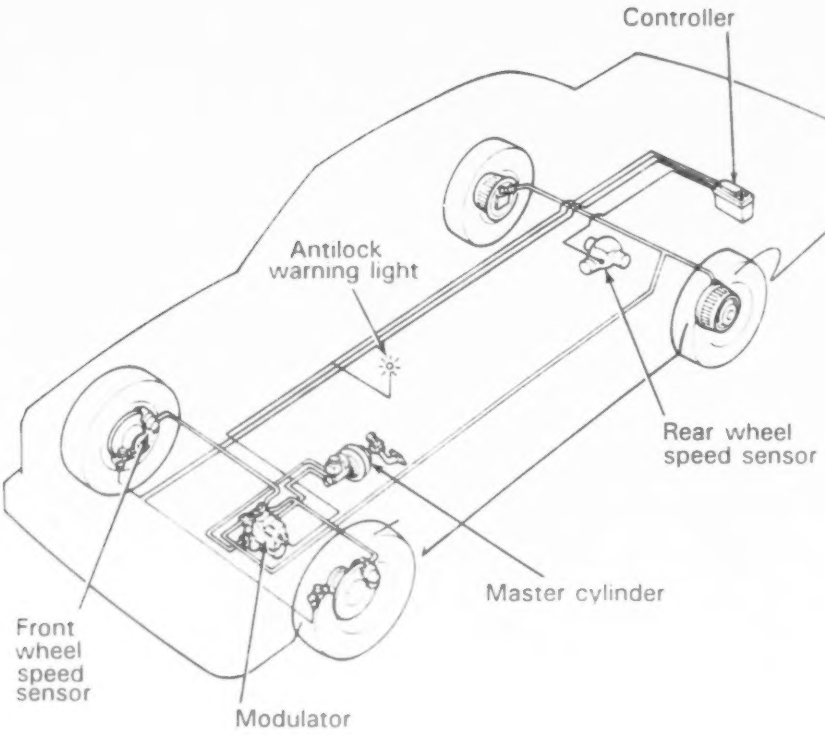
3. Type of ABS/SCS: ______________________________


Controller
Antilock warning light
Rear wheel speed sensor
Master cylinder
Front wheel speed sensor
Modulator

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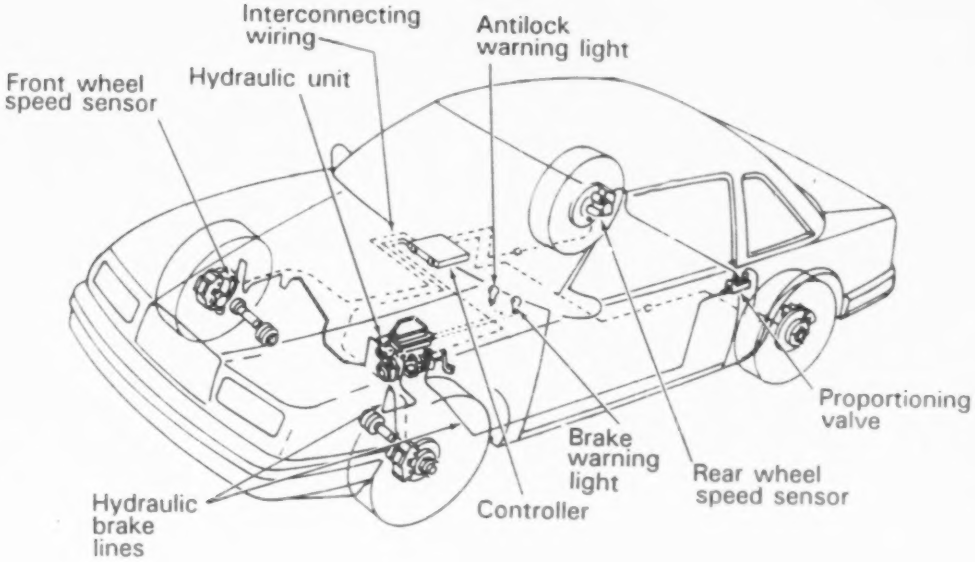
4. Type of ABS/SCS: ______________________________

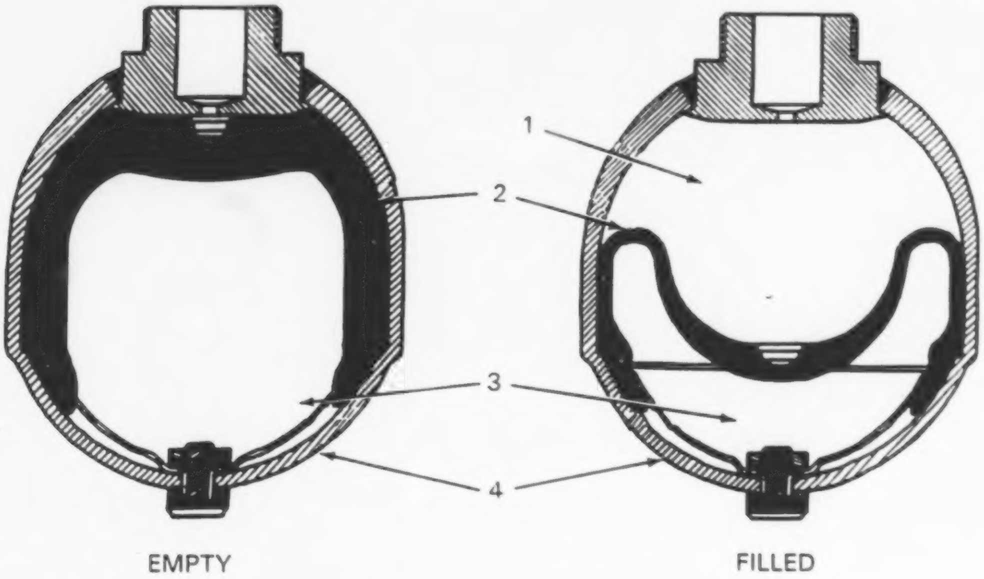
786


Interconnecting wiring
Antilock warning light
Front wheel speed sensor
Hydraulic unit
Proportioning valve
Brake warning light
Rear wheel speed sensor
Controller
Hydraulic brake lines

Copyright ©General Motors Corp. Used with permission.

5. Type of ABS/SCS: ______________________________

OBJECTIVE 6 | **Match the names of the parts of an accumulator to an illustration.** Place the letter of the part next to the illustration in the space provided.



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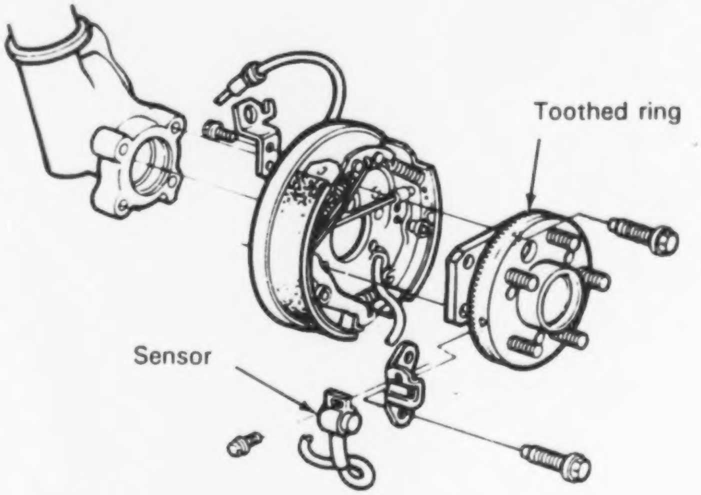
______	1.	a.	brake fluid
______	2.	b.	diaphragm
______	3.	c.	housing
______	4.	d.	nitrogen gas

OBJECTIVE 7

Identify types of wheel speed sensors from illustrations. Write the name of the type of wheel speed sensor shown in the space provided.

Drive Pinion Gear Wheel Speed Sensor
Front Wheel Speed Sensor
Rear Wheel Speed Sensor – Axle Mounted
Rear Wheel Speed Sensor – Hub Mounted


Toothed ring
Sensor

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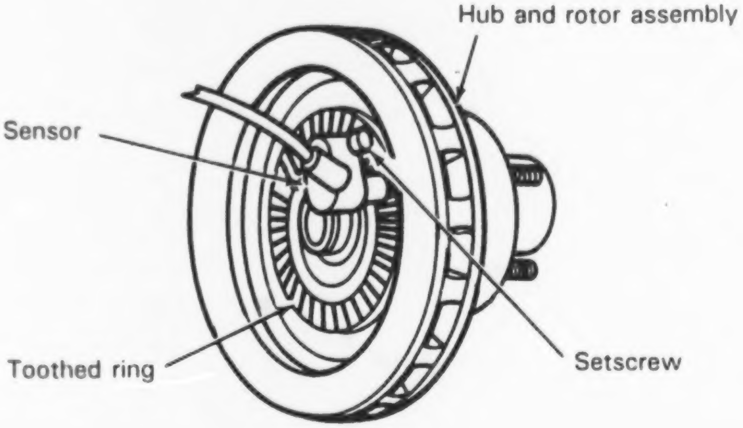
1. Type of wheel speed sensor: ______________________


Hub and rotor assembly
Sensor
Toothed ring
Setscrew

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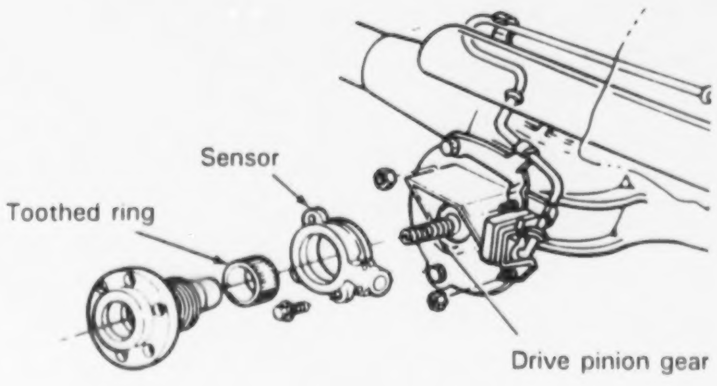
2. Type of wheel speed sensor: ______________________


Sensor
Toothed ring
Drive pinion gear

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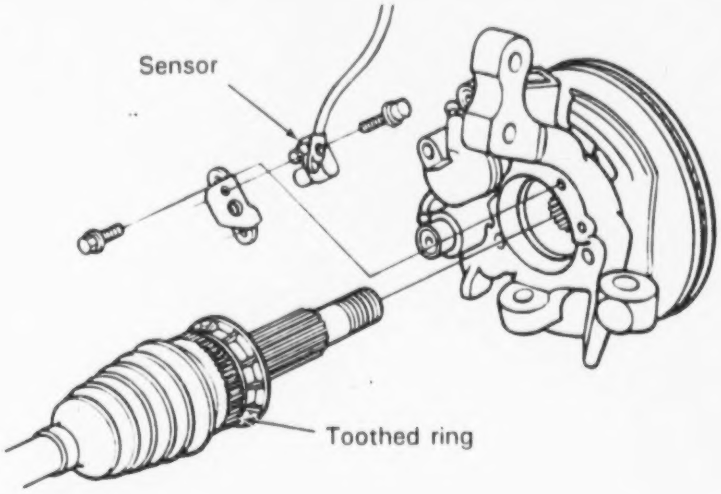
3. Type of wheel speed sensor: ______________________


Sensor
Toothed ring

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4. Type of wheel speed sensor: ______________________

770

OBJECTIVE 8 **Identify differences in servicing and operation between antilock brake systems and regular brake systems.** Put an "R" in front of phrases that describe the operation or servicing of a regular brake system. Put an "A" in front of phrases that describe the operation or servicing of an antilock brake system.

Operating Difference:

_______ 1. Wheels are pumped and lockup prevented without driver awareness or involvement

_______ 2. Driver must pump brakes manually after lockup occurs to control the vehicle

Servicing Differences:

_______ 3. Master cylinders are designed to withstand high pressure and cannot be rebuilt

_______ 4. Most master cylinders can be rebuilt

_______ 5. Manual brake bleed is acceptable

_______ 6. Brakes should not be bled manually

_______ 7. Frequent flushing or brake fluid replacement not required

_______ 8. Brake fluid must be flushed and replaced often

_______ 9. The high pressure used requires special safety precautions during servicing

_______ 10. No special high pressure safety precautions are required

_______ 11. Most parts are not serviceable

_______ 12. Most parts are serviceable

_______ 13. There are many components and they are expensive

_______ 14. There are fewer, more inexpensive components

OBJECTIVE 9

List safety precautions for inspecting, testing, and servicing antilock brake systems. Write the safety precautions in the blanks under the correct category.

Inspecting Precautions:

- ____
  ____
- ____
  ____
- ____
  ____

Testing Precautions:

- ____
  ____
- ____
  ____
- ____
  ____
- ____
  ____

Servicing Precautions:

- ____
  ____
- ____
  ____
- ____
  ____
- ____
  ____

WRITTEN
TEST ANSWERS

SERVICING ANTILOCK BRAKE SYSTEMS

IV

OBJECTIVE 1

1. c
2. a
3. c
4. b
5. b
6. b
7. d
8. b
9. a

OBJECTIVE 2

1. d
2. c
3. g
4. j
5. a, f, h, i

OBJECTIVE 3

1. b
2. j
3. c
4. g
5. e

OBJECTIVE 4

1. h
2. a
3. b
4. j
5. g
6. f
7. e
8. c
9. i
10. d

OBJECTIVE 5

1. Lucas–Girling SCS
2. Teves ABS
3. Bendix ABS
4. Bosch ABS 2U
5. Delco Moraine ABS

OBJECTIVE 6

1. a
2. b
3. d
4. c

OBJECTIVE 7

1. Rear Wheel Speed Sensor – Hub Mounted
2. Front Wheel Speed Sensor
3. Drive Pinion Gear Wheel Speed Sensor
4. Rear Wheel Speed Sensor – Axle Mounted

OBJECTIVE 8

1. A
2. R
3. A
4. R
5. R
6. A
7. R
8. A
9. A
10. R
11. A
12. R
13. A
14. R

OBJECTIVE 9

The answer should contain all of the following:

Inspecting Precautions:

- Do not road test vehicles if the brake warning light is lit.
- Wear safety glasses when inspecting brake lines and hoses.
- Do not chafe or abuse wheel sensors or their cables when you inspect brakes.

Testing Precautions:

- Use only a digital multimeter for electrical testing.
- When you are testing, use only gauges and hoses capable of withstanding several thousand pounds of pressure.
- Do not probe wiring or harness connections–use a breakout box.
- Do not activate solenoids for more than 30 seconds.

Servicing Precautions:

- Depressurize the hydraulic accumulator before performing any service operations.
- Use ***only*** D.O.T. 3 brake fluid.
- Replace the antilock controller with the proper part.
- Disconnect the controller before arc welding anywhere on the vehicle body.

BRAKES SPECIALIST (SECOND EDITION)

CI

READING SKILLS

WRIT.

UNITS OF INSTRUCTION STATE/LOCAL CODES*	Reading Comprehension									Research and Reference								Functional Reading						Language		Composition								Resea		
	Gain factual information	Distinguish fact, opinion and inference	Recognize stereotyping and bias	Recognize propaganda	Analyze cause and effect	Draw conclusions	Make generalizations	React to written material	Apply word analysis techniques	Select useful resources	Locate resources	Find materials in library	Use standard references	Use in-book reference tools	Use audiovisual media	Use computer data base	Use magazines and newspapers	Interpret forms and records	Follow written instructions	Interpret graphics and symbols	Use content area vocabulary	Interpret abbreviations/acronyms	Read aloud	Use standard grammar and correct spelling, punctuation, and capitalization	State ideas clearly	Use complete sentences	Develop preliminary outline	Use topic sentences	Use introductory/closing paragraphs	Compose reports	Compose essays	Proofread and edit	Construct graphics and symbols	Take notes	Use notecards	Create bibliography
Service Brake Hydraulic System and Wheel Bearings	●												●	●					●	●	●															
Service Drum Brakes													●	●					●	●																
Service Disc Brakes													●	●					●	●																
Service Antilock Brakes						●							●	●					●	●	●	●														

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CIMC BASIC SKILLS DOCUMENTA

WRITING SKILLS

MATH SKILLS

Research					Functional Writing							Operation and Calculation														Math Application											Data Analysis and Display									
Take notes	Use notecards	Create bibliography	Use footnotes	Outline material	Complete forms and records	Write instructions	Write letters	Write job applications	Write resumes	Use word processing	Use computer graphics	Round off numbers	Estimate answers	Use scientific notations	Use exponential notations	Calculate with whole numbers	Calculate with fractions	Calculate with decimals	Convert whole numbers to fractions	Convert whole numbers to decimals	Solve numerical expressions	Solve formulae and equations	Obtain squares and square roots	Convert units of measure	Perform metric calculations	Solve word problems	Select/apply mathematical formula	Select/apply mathematical procedure	Use English and metric measures	Solve time/rate/distance problems	Solve ratio-proportion problems	Solve percent problems	Apply techniques of scaling	Apply algebra principles	Apply geometry principles	Apply trigonometry principles	Interpret charts and tables	Interpret graphs (type)	Collect/record data	Apply sampling techniques	Apply principles of probability	Construct charts and tables	Construct graphs	Calculate statistics	Interpret statistics	Interpret blueprints/plans
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SCIENCE SKILLS

94 010374

				Functional Math										General Science									Life Science							Physical Science					Earth Science							
Make measurements	Perform banking transactions	Make change	Solve practical problems	Calculate gross earnings	Solve income expense problems	Prepare a budget	Calculate interest	Solve interest problems	Calculate sales tax	Determine income tax	Use calculator for computation	Use computer for computation	Use computer spreadsheets	Apply computing skills	Apply scientific method of inquiry	Conduct experiments	Investigate science ethics	Investigate science history	Investigate/apply economics in technology	Use scientific instruments	Investigate/apply technology	Collect specimens	Identify/classify living organisms	Investigate biological history of the earth	Investigate food chains, webs, pyramids	Investigate/apply principles of human development	Investigate/apply principles of genetics/heredity	Investigate/apply principles of anatomy/physiology	Investigate health issues	Analyze/classify matter	Investigate forms/changes of matter	Investigate forms/changes of energy	Investigate/apply chemical properties	Investigate/apply physical laws	Investigate physical characteristics of the earth	Investigate geological history of the earth	Investigate physical forces acting on the earth	Solve problems of longitude, latitude, and time zones	Investigate conservation of physical resources	Investigate conservation of living resources	Investigate issues of environmental impact	Apply science principles to environmental issues
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ORAL COMMUNICATIONS SKILLS

UNITS OF INSTRUCTION STATE/LOCAL CODES*	Oral Presentation									Listening				Interactive Communication									
	Make informative presentations	Make persuasive presentations	Present personal opinion/viewpoint	Use good speaking techniques	Select/use words effectively	Use effective body language	Present appropriate appearance	Integrate audio and/or visual materials in oral presentations	Adapt presentation to specific audience	Apply active listening skills	Distinguish fact, opinion, and interference	Draw conclusions/make generalizations	Analyze/identify point of view	Give/follow oral directions	Apply questioning techniques	Conduct/receive interviews	Analyze/apply nonverbal communication	Work effectively in a group	Communicate with clients/customers/patients	Communicate with co-workers	Communicate with supervisors	Communicate with professional colleagues/associates	Apply telephone etiquette
Service Brake Hydraulic System and Wheel Bearings																		●					
Service Drum Brakes																							
Service Disc Brakes																							
Service Antilock Brakes																							

INTERPERSON

UNITS OF INSTRUCTION STATE/LOCAL CODES*	General Relating																
	Investigate/apply communication process models	Analyze/apply nonverbal communication	Investigate/apply cross-cultural communication	Interact with co-workers	Interact with supervisors	Interact with clients/customers/patients	Interact with professional colleagues/associates	Interact with family/friends	Participate in group activities	Participate in industrial relations/functions	Identify personal values/attitudes	Apply information to life experiences	Identify values/attitudes	Identify needs/drives	Select/apply appropriate behavior	Investigate/identify personal styles	Investigate/identify group/
Service Brake Hydraulic System and Wheel Bearings				●					●								
Service Drum Brakes																	
Service Disc Brakes									●								
Service Antilock Brakes																	

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AL OR RELATING SKILLS

CREATIVE THINKING/ PROBLEM SOLVING SKILLS

EMP

Teamwork Cooperation											Leadership Influence							Cognitive Activities																				Job Search Selection									
corporate climate	Give/receive feedback	Identify hidden purposes	Investigate/apply group dynamics	Control undesirable inappropriate behavior	Resolve conflicts	Clarify goals/objectives	Devise "win/win" situations	Build consensus	Generate ideas	Present point of view	Analyze/apply leadership styles	Analyze/apply management styles	Obtain confidence of others	Develop esteem in self/others	Persuade others	Analyze/apply motivation techniques	Provide positive coaching	Collect/record information	Identify critical elements/issues	Define a problem	Identify underlying causes	Apply a problem-solving model	Analyze/synthesize information	Identify/analyze underlying assumptions	Draw conclusions	Predict results/outcomes	Identify/evaluate consequences	Identify/develop alternatives	Evaluate alternatives	Select an alternative	Devise a solution	Create a finished product	Apply intuitive/creative thinking processes	Transfer knowledge/training to new situations	Apply new technology	Develop an action plan	Evaluate results/outcomes	Analyze personal occupational aptitudes/preferences	Investigate employment prospects of a career field/occupation	Investigate training requirements for a career field/occupation	Investigate benefits of a career field/occupation	Compare/evaluate career options	Develop personal career path	Locate appropriate jobs	Analyze duties/requirements/benefits of specific job		
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LOYABILITY SKILLS

SOCIAL STUDIES SKILLS

Job Acquisition Development														Information Analysis						Social Studies Application										Functional Social Studies														
Master specific job task/procedure	Fill in job-related applications	Write letter of application	Write personal resume	Interview for a job	Apply business etiquette	Practice good work habits/attitudes	Develop good personal presentation	Develop self-confidence/esteem	Develop effective leadership	Deal effectively with supervisors	Deal effectively with co-workers	Deal effectively with professional colleagues/associates	Deal effectively with customers/clients	Collect/record data	Interpret graphical information	Construct graphical information	Interpret maps/globes	Interpret statistical information	Analyze/interpret demographic information	Investigate/apply U.S. history	Investigate/apply world history	Investigate/apply U.S. geography	Investigate/apply world geography	Investigate/apply principles of government/politics	Investigate/apply principles of economics	Investigate/apply principles of ethics	Investigate/apply principles of psychology	Investigate/apply principles of sociology	Investigate/apply cross-cultural studies	Practice responsible personal economics	Prepare a personal budget	Use credit responsibly	Practice good work ethics	Participate in industrial relations	Interact with people of different races/cultures	Investigate/participate in government	Investigate/apply American legal practices	Select/use sources of information on current events	Analyze current events	Analyze consumer issues	Analyze social issues	Analyze conservation/ecology issues	Analyze social impact of science/technology	Analyze economic impact of science/technology
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